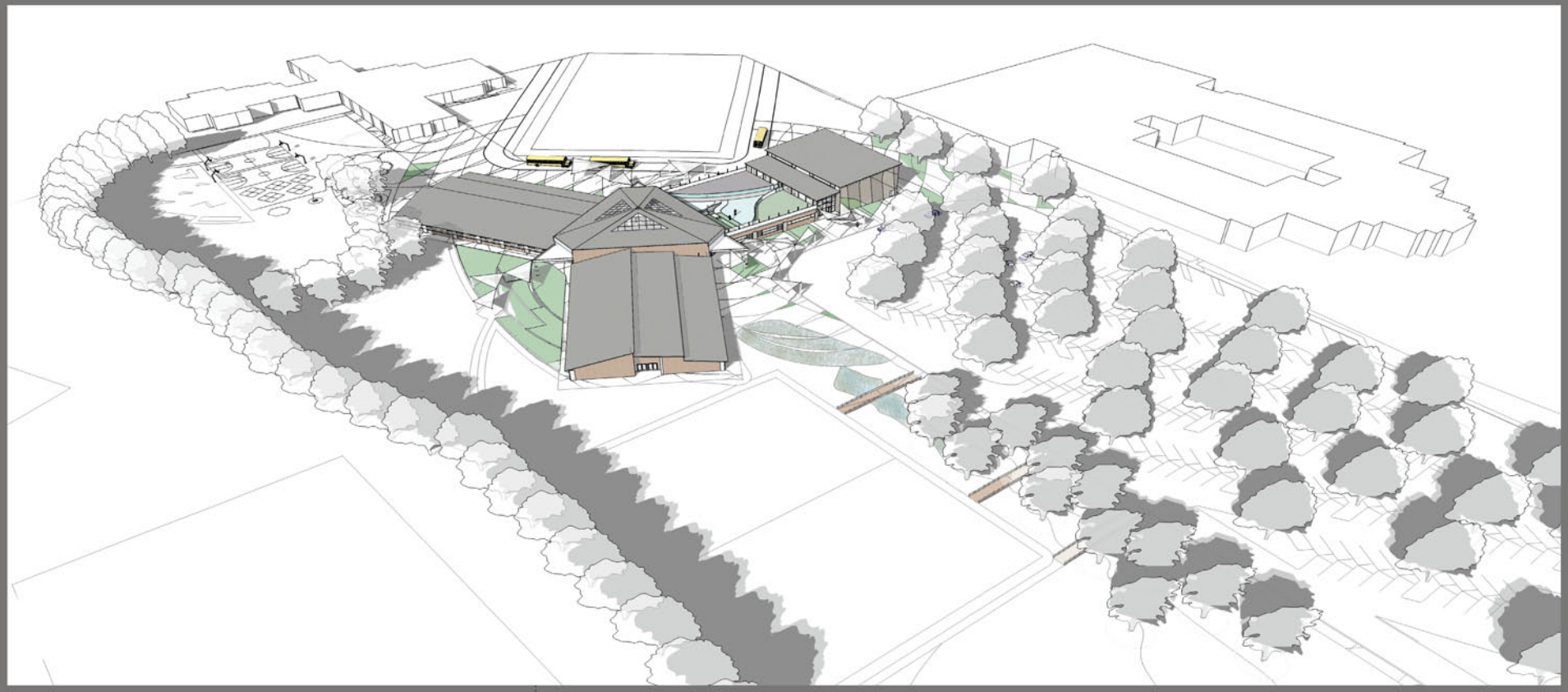


Proposal for State College Area School District's

Mount Nittany Elementary School

INTEGRATED PROJECT DELIVERY / BUILDING INFORMATION MODELING STUDIO - SPRING 2011

INTEGRATED DESIGN SYSTEMS (IDS)

Architect	Ross Weinreb
Construction	Andrew Menyo
Landscape Architect	Chris Joseph
Lighting/Electrical	Simi Veit
Mechanical	Jim Rodgers
Structural	Logan Gray

The Pennsylvania State University

Department of Architecture
Department of Landscape Architecture
Department of Architectural Engineering

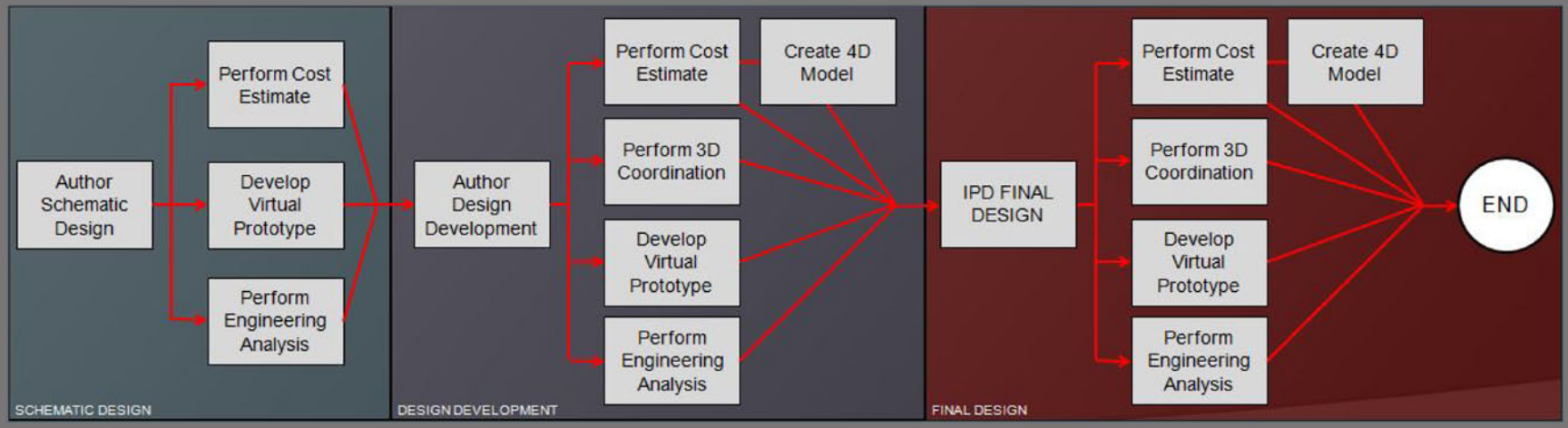
Submitted

2 May 2011

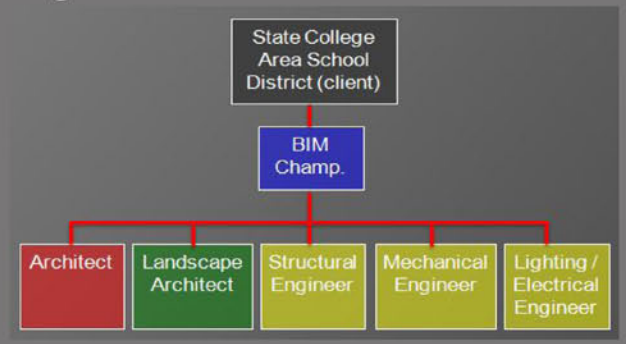
Our mission is to integrate the fields of Architecture, Engineering and Construction to produce spaces that heighten the human experience. Seamless collaboration and a sustainable mantality, help us to design and construct buildings which mesh with the surrounding environment. Combining integrated project delivery with BIM, we ensure the highest quality program from concept to completion.

Contents

BIM Team Process Map



Organizational Rolls



top: The BIM Team Process Map shows the necessary channels and order of project development

left: This graphic depicts the organizational rolls and staffing of a well-oiled BIM group

BIM Execution Plan

Architecture

In the early phases of the project, architecturally we were mostly interested in solar orientation, site access, and broad picture decisions like materials, space relationships, and program requirements.

Construction

Development of the BIM Execution plan was a primary focus through this phase. Work flow was a key component to team collaboration and a valuable takeaway. Lead / lag was also a focus and directed individual team deadlines to achieve success as a team. Preliminary software integrations were also discussed to ensure seamless work flow.

Landscape Architecture

Initial site analysis was completed including: slope, wind, solar orientation, soil conditions, viewsheds, existing utilities, existing stormwater infrastructure. Close collaboration with the entire team to ensure a clear vision for both the building and landscape was crucial for a collaborative design that met our established criteria.

BIM Goals

PRIORITY (HIGH/ MED/ LOW)	GOAL DESCRIPTION
High	Seamless workflow integration of all disciplines
High	LEED Certification (Gold)
High	Improve design efficiency
Low	Efficient constructability
Med	Become proficient with advanced building modeling and model share

left: Setting clear goals and establishing a means of accomplishing them is one of the quickest ways to organize your thoughts as a collective

right: Not every project will require every function of BIM technology. Weed out the unnecessary and save your group even more time

below: There is no replacement for face-to-face engagement with group members for clarification of potential complications or design issues. The more time you spend with your group the more comprehensive your product will be

Allocated BIM Uses

	PLAN		DESIGN		CONSTRUCT
	PROGRAMMING	X	DESIGN AUTHORING	X	SITE UTILIZATION PLANNING
X	SITE ANALYSIS	X	DESIGN REVIEWS		CONSTRUCTION SYSTEM DESIGN
		X	3D COORDINATION	X	3D COORDINATION
		X	STRUCTURAL ANALYSIS		DIGITAL FABRICATION
		X	LIGHTING ANALYSIS		3D CONTROL AND PLANNING
		X	ENERGY ANALYSIS		RECORD MODELING
		X	MECHANICAL ANALYSIS		
			OTHER ENG. ANALYSIS		
		X	SUSTAINABLITY (LEED) EVALUATION		
		X	CODE VALIDATION		
	PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)	X	PHASE PLANNING (4D MODELING)
X	COST ESTIMATION	X	COST ESTIMATION	X	COST ESTIMATION
X	EXISTING CONDITIONS MODELING	X	EXISTING CONDITIONS MODELING	X	EXISTING CONDITIONS MODELING

Communication Development

MEETING TYPE	PROJECT STAGE	FREQUENCY	PARTICIPANTS	LOCATION
WORK SESSIONS	ALL	2 PER WEEK / AS NEEDED	ALL	307 SACKETT
BIM EXECUTION PLAN	PRELIMINARY	M/W/F UNTIL COMPLETE	ALL	SALA BUILDING
SCHEMATIC DESIGN	SCHEMATIC DESIGN	2 PER WEEK	ALL	SALA BUILDING
SUSTAINABILITY IDEAS	SCHEMATIC DESIGN	AS NEEDED	ALL	SALA BUILDING
DAYLIGHTING ANALYSIS	DESIGN DEVELOPMENT	AS NEEDED	ARCH, L ARCH, LE	307 SACKETT
ENERGY ANALYSIS	DESIGN DEVELOPMENT	AS NEEDED	ARCH, MECH, LE	307 SACKETT
STUCTURAL ANALYSIS	SCHEMATIC/DESIGN DEVELOPMENT	AS NEEDED	ARCH, STRUCTURAL ENGR	307 SACKETT
CONSTRUCTABILITY REVIEWS	ALL	ONCE EVERY 2 WEEKS	CM, WITH EACH DESIGNER	307 SACKETT

Communication via face-to-face meetings provides greater benefits inherent to close proximity. Questions can be answered as needed immediately and a conference call is as easy as addressing the group. There is no substitute for this interaction, but a close second is working with a group that is willing to tolerate getting text messages via GroupMe at any hour of the day.

Lighting/Electrical

Without a building to design in the early stages, determining how to use the BIM process and what to attain through it were primary foci. Concentrating on setting achievable goals that pushed the known limits of a standard BIM project was a challenge we wanted to meet.

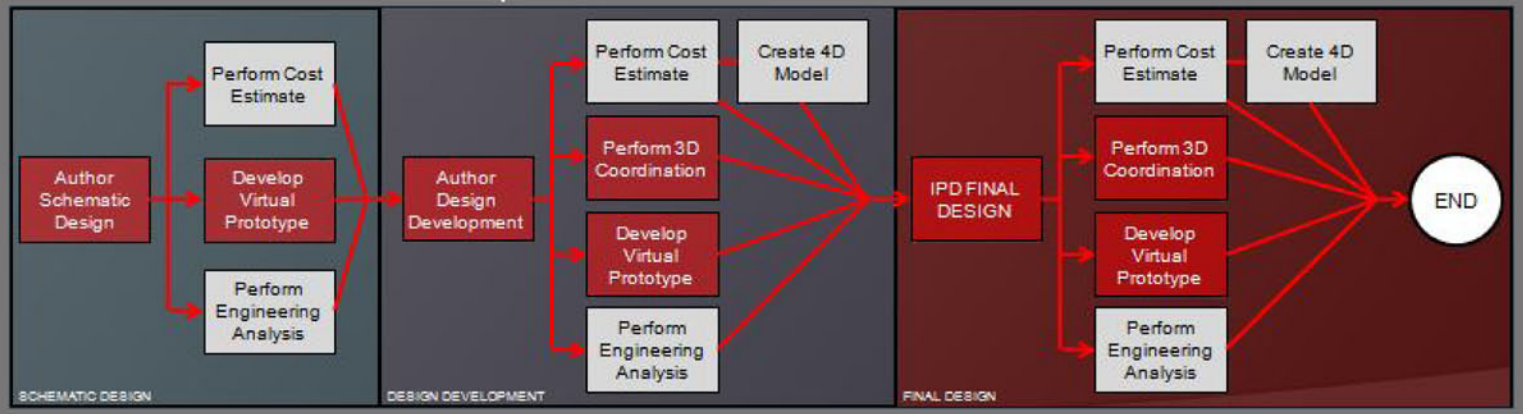
Mechanical

Development of a mission statement became important to convey our groups ideals and desires with this project. Communication became a priority early and we worked on creating efficient means to do so. A smart phone application called GroupMe (a text messaging chat room) was quickly discovered and became our primary source of electronic communication.

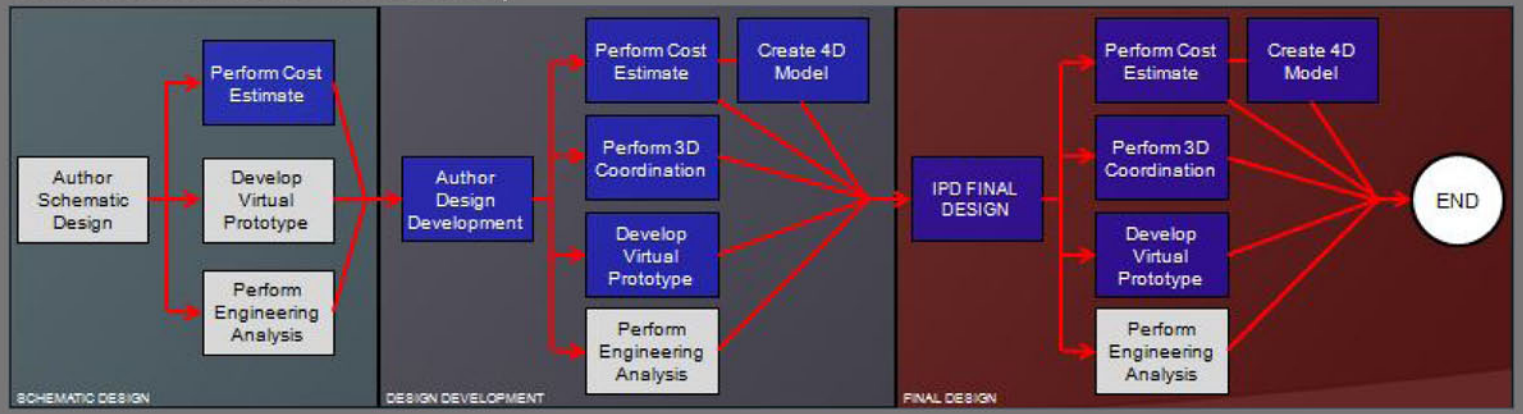
Structural

Throughout the BIM Ex Plan process, structural analysis software and BIM Software integration was explored. Clash detection software was deemed important for system integration and was chosen as an important BIM goal. Site specific analysis was conducted for its influence on design (i.e. seismic, wind, snow, and geotechnical).

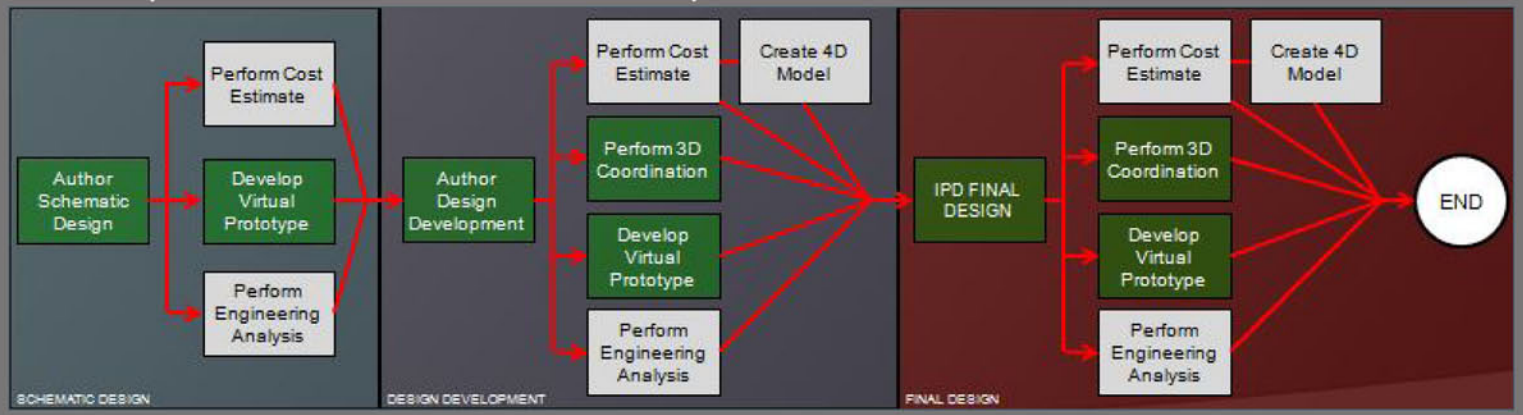
Architectural BIM Process Map



Construction BIM Process Map



Landscape Architectural BIM Process Map



Each design discipline must be present through each phase of design. If this is achieved, many problems can be solved before they fully materialize. Input from each member helps to reduce costly changes to the project later (i.e. change orders and clashes). If the design can be monitored by each set of eyes through every step of the development process, a more cohesive final product will result in a much shorter period of time.

top: The Architectural deliverables and inputs through each phase of project development in red

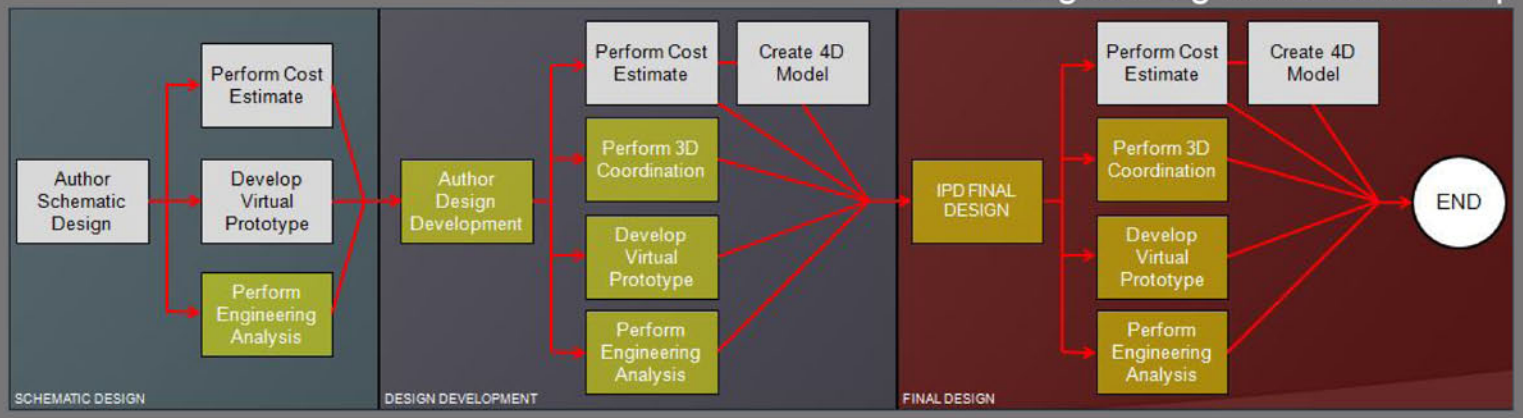
middle: The Construction inputs contribute a great deal to each phase of development (shown in blue)

left: The Landscape Architectural inputs tied closely to the architectural design and inputs (shown in green)

Engineering BIM Process Map

right: Engineering inputs including Lighting/Electrical, Mechanical, and Structural (shown in yellow)

bottom: An example of the information exchange process as a collective, BIM discipline



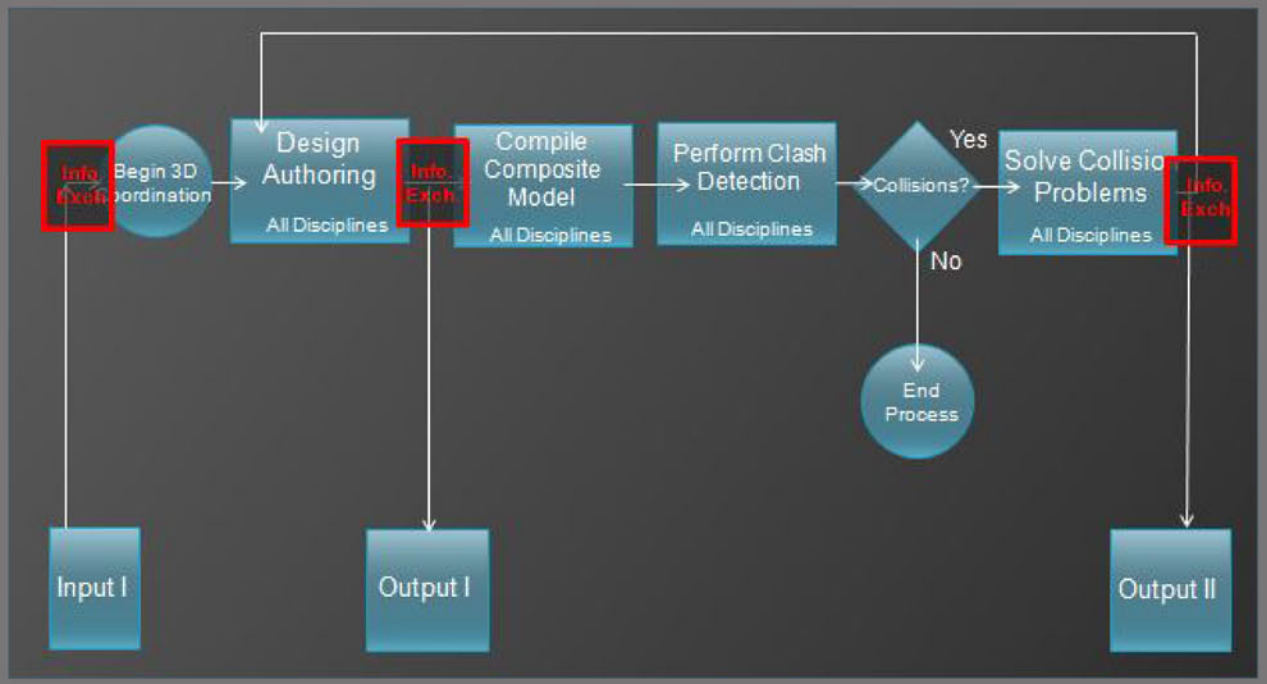
Information Exchange Example

Information exchange is one of the most critical elements of a successful BIM project. Each team member must have input at nearly every phase to ensure limitations of errors and maintaining a fully-encompassing model (this is important from project conception through completion)

Input I:
Architectural Model(ARCH),
Existing Site Conditions(LARCH)

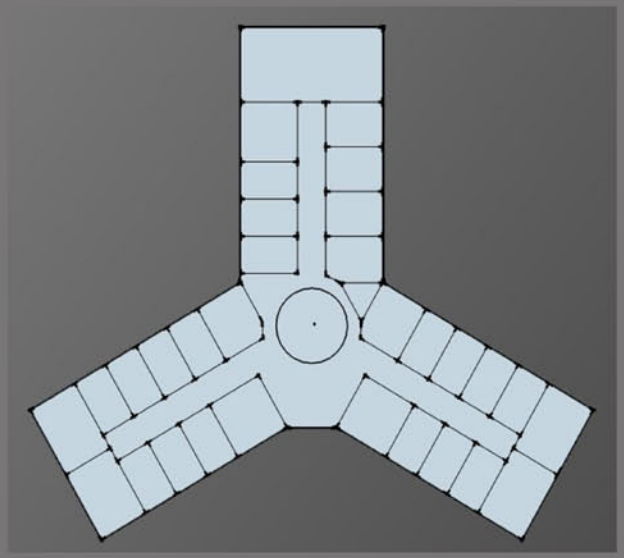
Output I:
Structural Model(SE),
Mechanical Model(ME),
Lighting and Electrical Model(L/E),
Landscape(LARCH)
Site Model(CM)

Output II:
Collision-Free 3D Model(ALL)



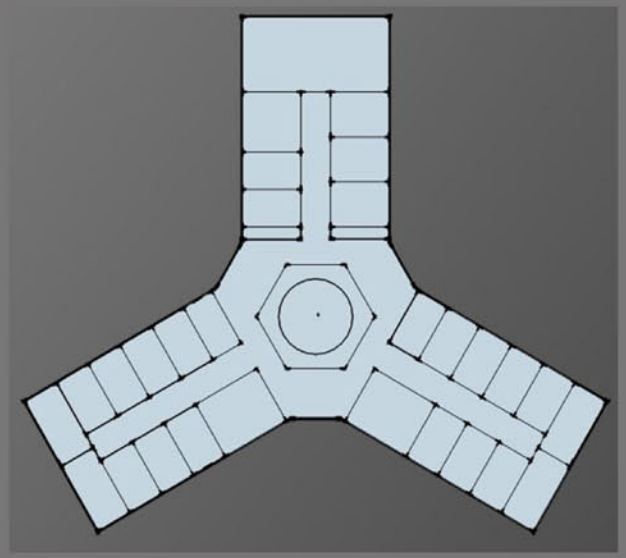
Schematic Layout I

Each iteration of the schematic design had benefits and pitfalls.



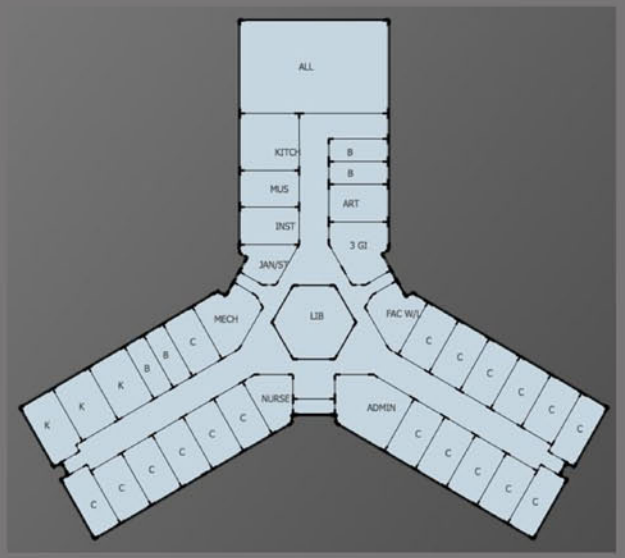
II.

As the central corridor began to take precedence, some of the peripheral spaces began to be forgotten.



III.

This was caught early through a collaborative critique and these forgotten spaces began to develop as useful locations of auxiliary occupance.



Schematic Design

Architecture

In this phase we selected the overall shape of our building. Everything stemmed from our central axis, which became our library. This became the focal point of our design because we wanted everything to radiate off of the library. Three wings were developed from the center to include the class-rooms and service spaces. This layout was selected because it would be the most efficient for integrating structure, mechanical, as well as ease of constructability.

Construction

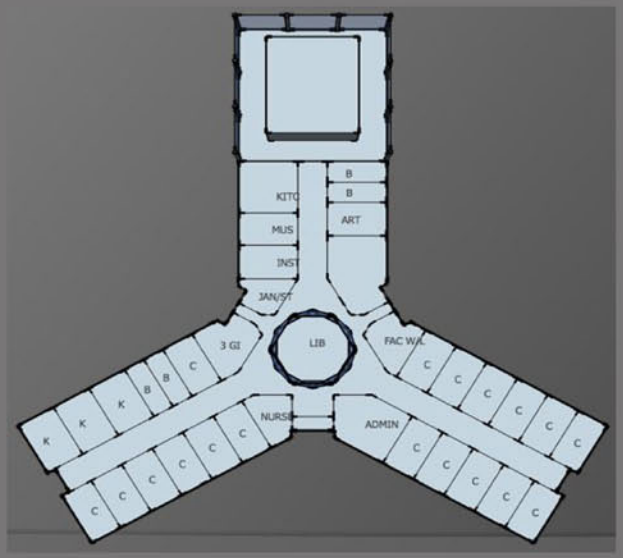
Confirmation of utility tie ins for each group mem-ber's needs was an initial task. Continued monitoring of each group member to ensure collaborative efforts were being made. Leading a site tour helped to familiarize each team member with existing conditions and instill a bit of imagination on the part of the designers. Photodocumentation of existing conditions was done for future reference. A preliminary schedule of design activity was established as well as a basic construction schedule. Cost estimation begins as the footprint of the building takes shape.

Landscape Architecture

Schematic design led to a series of trace iterations of circulation patterns and zones of programming being established. Following the community touchstones was key to ensure the meeting of design criteria. The existing conditions leant themselves to a multitude of possibilities so weighing each against the touchstones became a priority. Outdoor classrooms and engagement with the natural environment was meantioned multiple times through community engagement. Sustainability and the introduction of a natural environment were key focii.

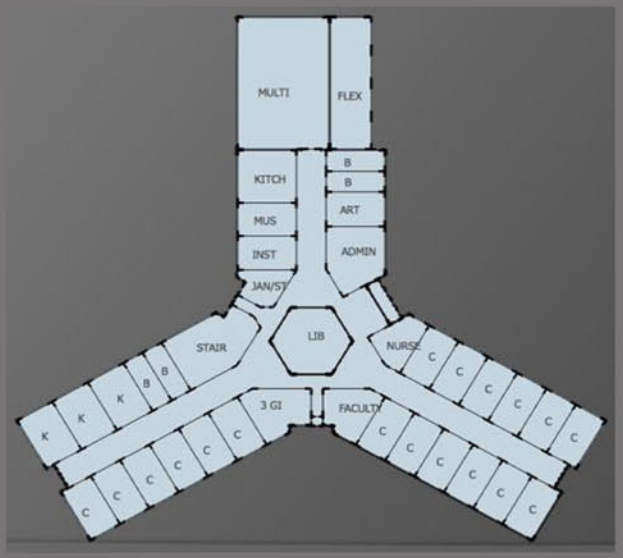
IV.

The library continues to take shape as a focal point of the design as a strong central element of the overall design.



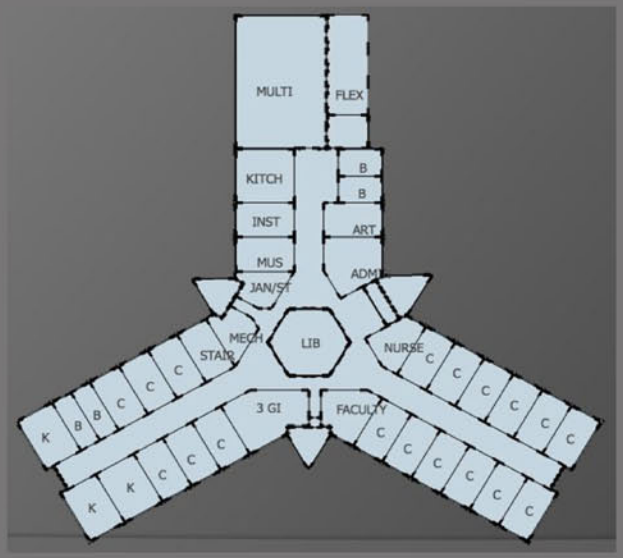
V.

The flex and multi-purpose space go through changes to better suit the aesthetics and orientation of the building and existing parking lot.



VI.

Overhangs at the entry points are added to emphasize the depth of each wing and the primary entrances to the building.



below: A crucial element of integrated workflows with multiple parties, the central file must be monitored carefully and set up to work seamlessly.

Lighting/Electrical

Solar orientation to maximize the daylighting potential of the new building was a primary focus through conceptual and schematic design. Continued research revealed some technologies in daylighting that conceptually worked well with our overall design (i.e. clerestories, overhangs, light shelves, window size, shading and glass types.) Clerestories were appropriately placed and overhangs were then sized. Preliminary illuminance levels were established for each room and it's end use as well.

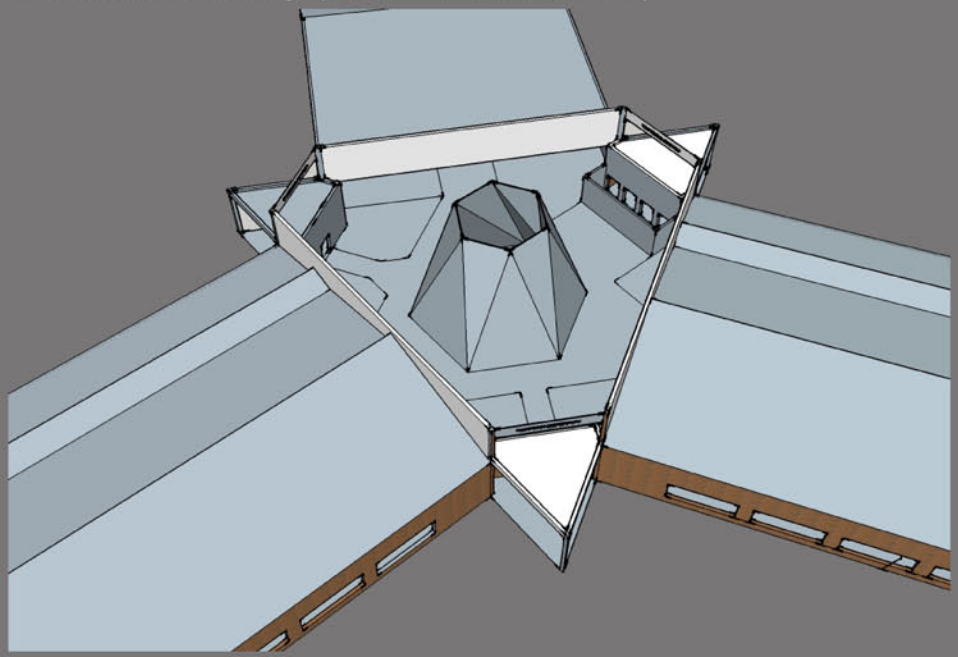
Mechanical

Throughout schematic design locating the mechanical room and key spaces that would pose mechanical challenges (i.e. the Multi-purpose and flex spaces) were key interests. Energy efficiency was also a concern as our LEED status (a community touchstone) depended upon our building and landscape being as energy efficient as possible. This in mind, close work with the architect to reduce glass surface area and with our lighting engineer helped to reduce unnecessary electrical lights and take advantage of daylighting opportunities.

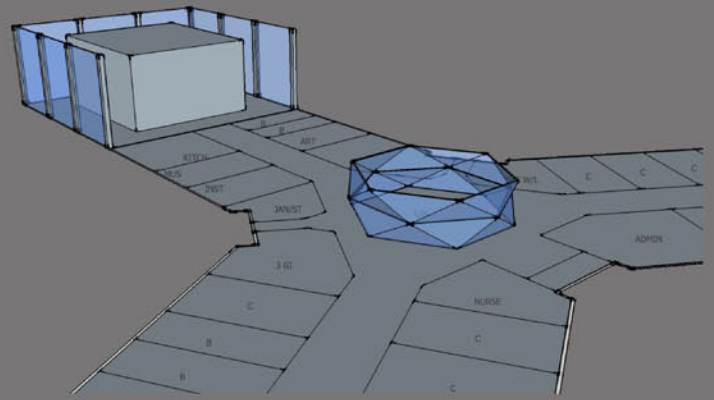
Structural

The central Revit was established in this phase. A basic structural layout was proposed for the existing building and changed as the early schematic design changed. Structural systems and building codes were researched for use in future development. As the building spaces were developed, a schematic column layout could be made. Various structural systems were explored for aesthetics, constructability and overall project integration. Basic ceiling heights, beam sizes, and shear wall locations were established.

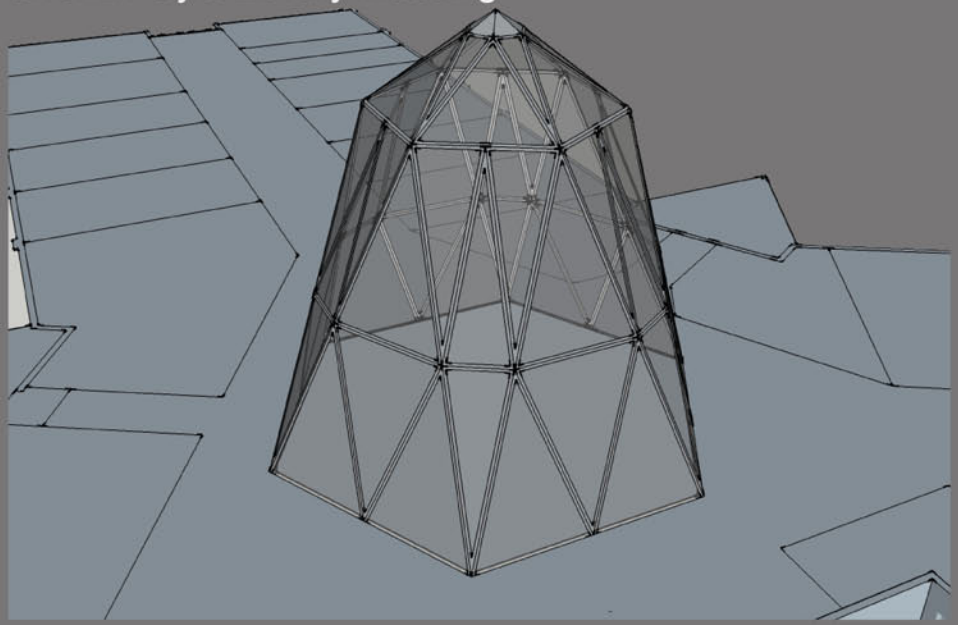
Schematic Library (without central roof)



Glazing Massing of Flex Space and Library



Gherkin-style Library Massing



top left: The spiraling appearance of the library created an interesting visual cue from the exterior of the building

bottom: Clearly inspired by the Gherkin, this interesting design was let go due to its mass and the difficulties it presented in relation to constructability

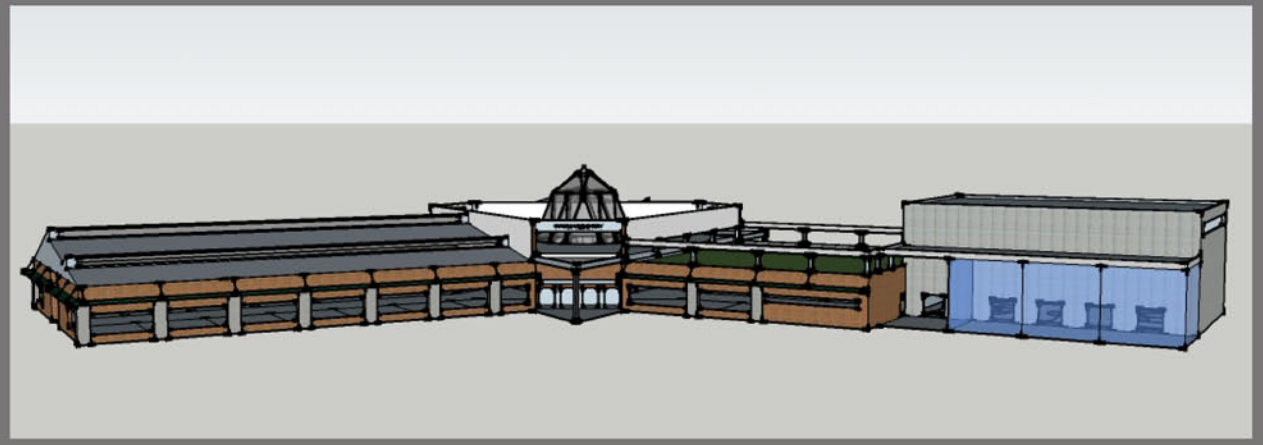
top: After a reduction in mass by losing ceiling height, the space began to look more feasible

Library Design

The library quickly became the central focus of the schematic design as its central location would filter throughout the rest of the design. Initial inspiration was drawn from the Gherkin building. The open structural design combined with the amount of glass used ultimately proved too much for an elementary school, but it did guide us towards the idea of natural lighting and a lower overhead plane within the library.

Entry Perspective

The winding access road to the existing parking lot provides a wonderfully curvelinear path that provides a brief reveal of the building facade before the main entrance is reached. Upon reaching the main entry drive through the parking lot, the linear structure creates a visual bowl directing the visual cue to the main entrance of the building. As the traffic circulation would be right to left in the image on the right, this creates an easy drop off point for both the primary entrance and the flex space for evening events. The repetition of geometry by the clerestories helps to emphasize this embracing pattern of movement.

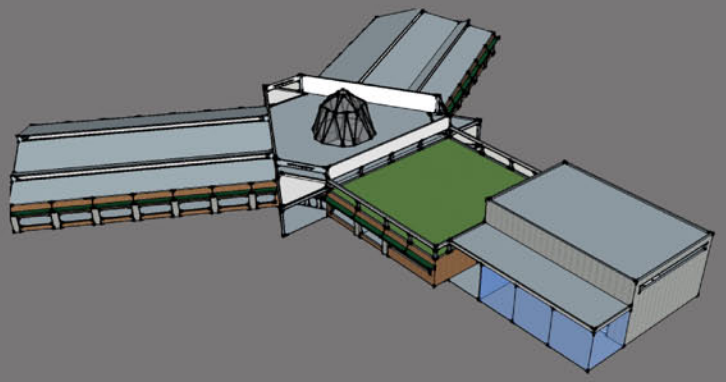


top: The brick facade embraces both the educational background of the building as well as the contextual surroundings

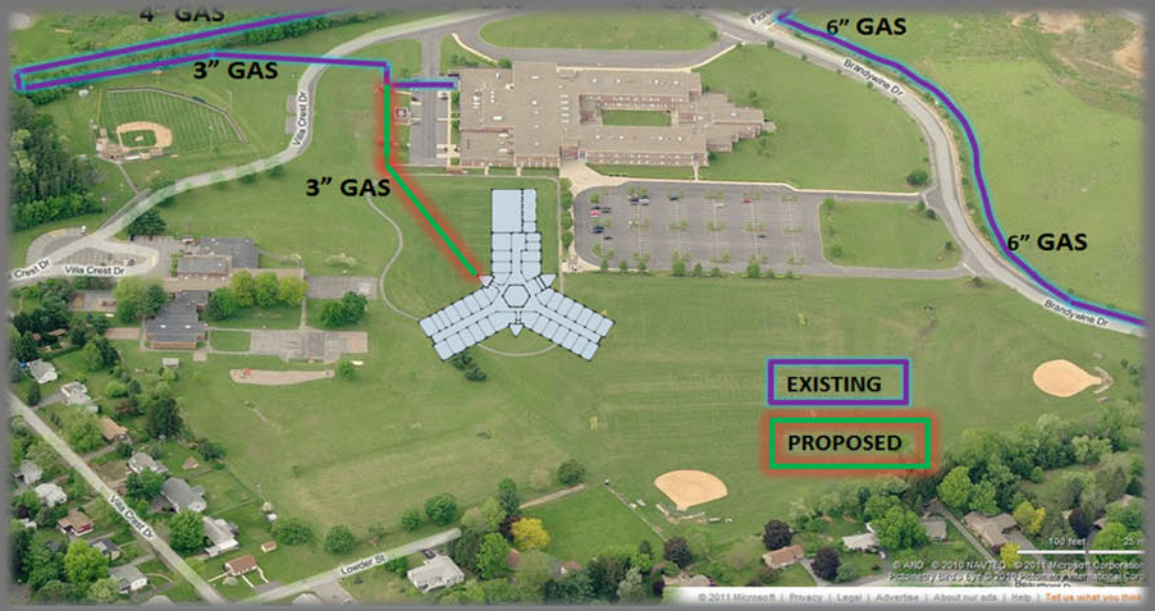
right: The location of a potential greenroof has been established above the service rooms (kitchen, storage, etc.)

bottom right: The pop-up clerestories mimic the linear geometry of the facade while providing daylight to the classrooms

bottom left: The library helps to maintain a focual cue to the center of the entry location

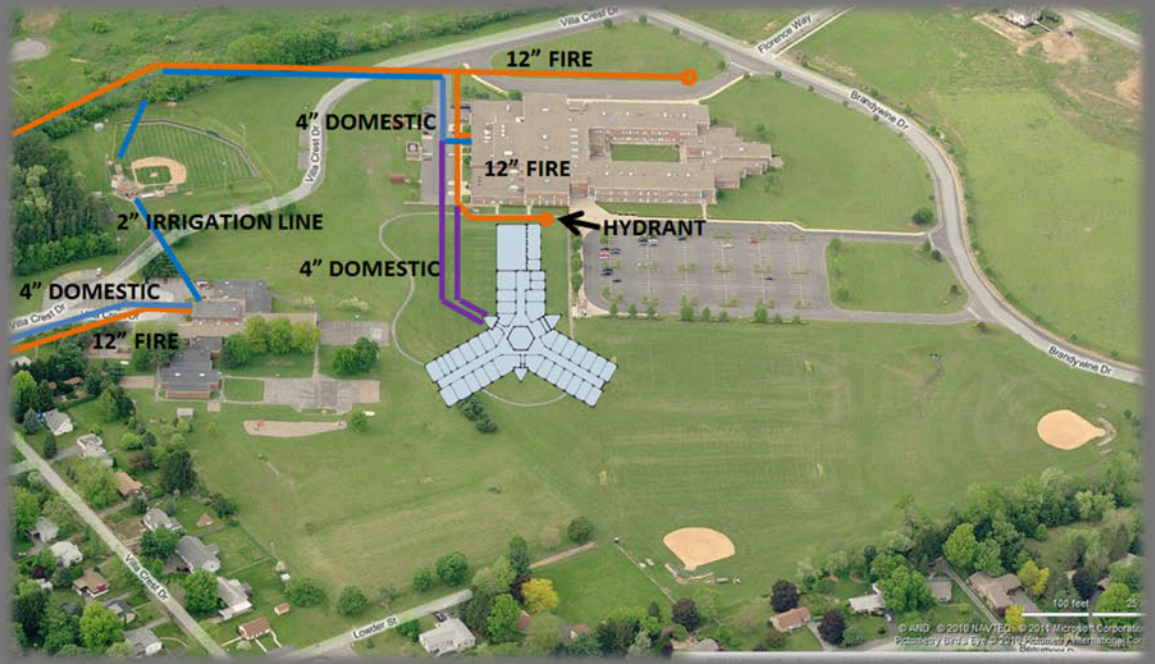


Primary Entrance



Gas Distribution Tie-In

As there are existing schools serviced by gas lines to the northwest of the proposed school, it is an easy connection to make. Code requirements for our zoning region will be met through the use of uninterruptable lines and a backup generate powered by either natural gas or diesel fuel.

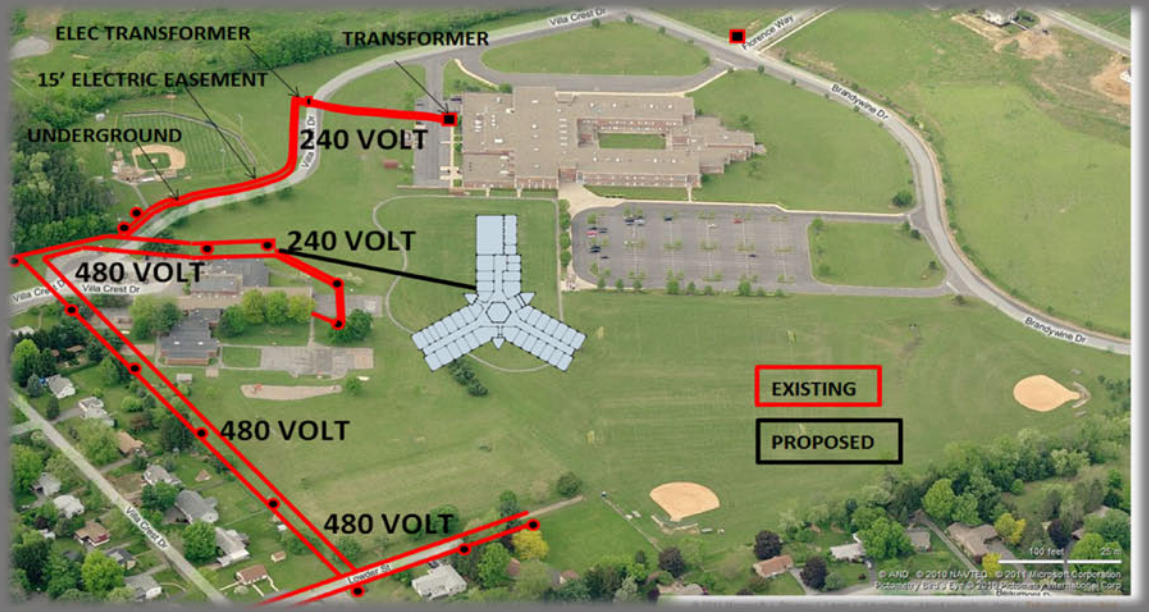


Domestic and Fire Water Lines

Again, the existing infrastructure helps as there is only a short distance to both a 4" domestic and a 12" fire line. The existing hydrant also meets our needs for servicing the proposed building.

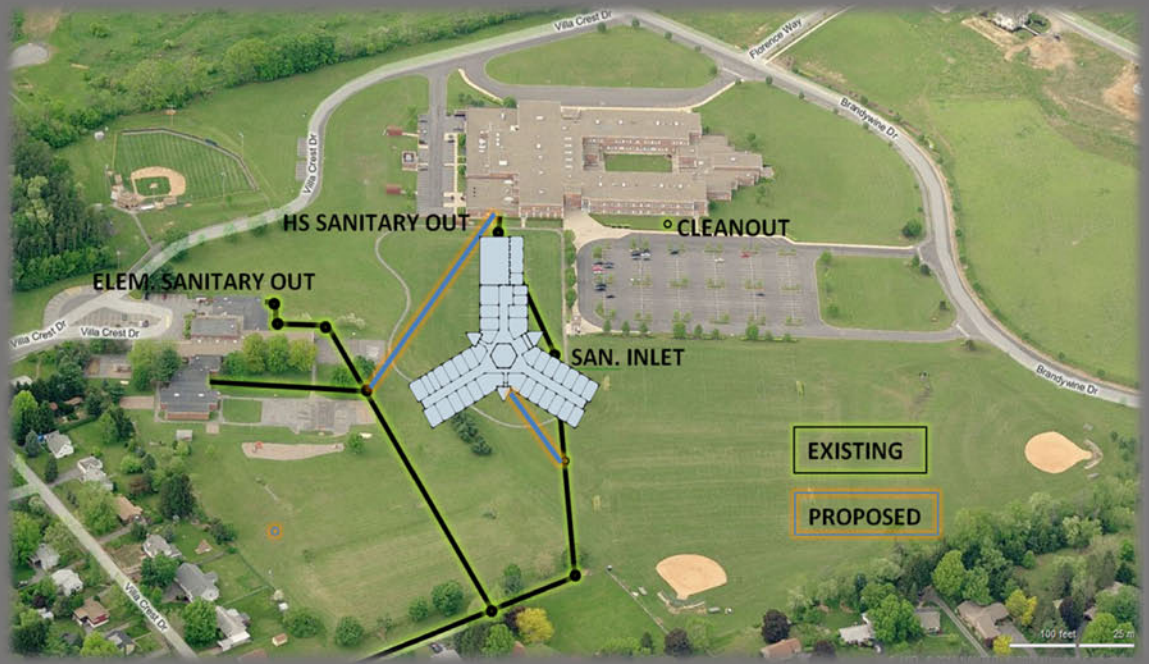
Electric Utility

Existing 480 volt lines run to a transformer to provide the existing elementary school with 280 volt power. A single line from this transformer meets the power requirements for the proposed elementary school.



Sanitary Sewer System

The existing lines will have to be redirected as the footprint of our proposed building covers it. However, the remaining line to the south of the building can be retrofitted to provide sanitary to the proposed building.



IESNA Design Criteria

Task	Appearance of Space and Luminaires	Color Appearance	Daylighting Integration and Control	Direct Glare	Flicker (and Strobe)	Light Distribution on Surfaces	Light Distribution on Task Plane (Uniformity)	Luminances of Room Surfaces	Modeling of Faces or Objects	Point(s) of Interest	Reflected Glare	Shadows	Source/Task/Eye Geometry	Sparkle/Desirable Reflected Highlights	Surface Characteristics	System Control and Flexibility	Illuminance (Horizontal)	Value	Illuminance (Vertical)	Value
Corridors																				10 fc
Classroom (Chalk Boards)																		50fc		
Pencil Written Tasks																		30fc		
Art Rooms																		50fc		30fc
Gymnasiums (Basketball)																		100fc		30fc
Cafeteria / Dining																		10fc		3fc
Kitchen																		50fc		3fc
Administrative Office (intermittent VDT use)																		50fc		5fc
Library (Reading Stacks)																		30fc		
Music Room																		50fc		
Bathroom																		5fc		3fc

Very Important	
Important	
Somewhat Important	
Not important or not applicable	

Daylighting as a Design Criteria

Focus on daylight to minimize energy consumption and the utilization of a wonderful natural resource directed much of the design of glazing and the buildings orientation. State College has rather unique weather characteristics which make designing for advantageous daylighting a particular challenge.

Number of fair days - 88
Number of cloudy days - 139
Number of overcast days - 120

LEED Monitoring

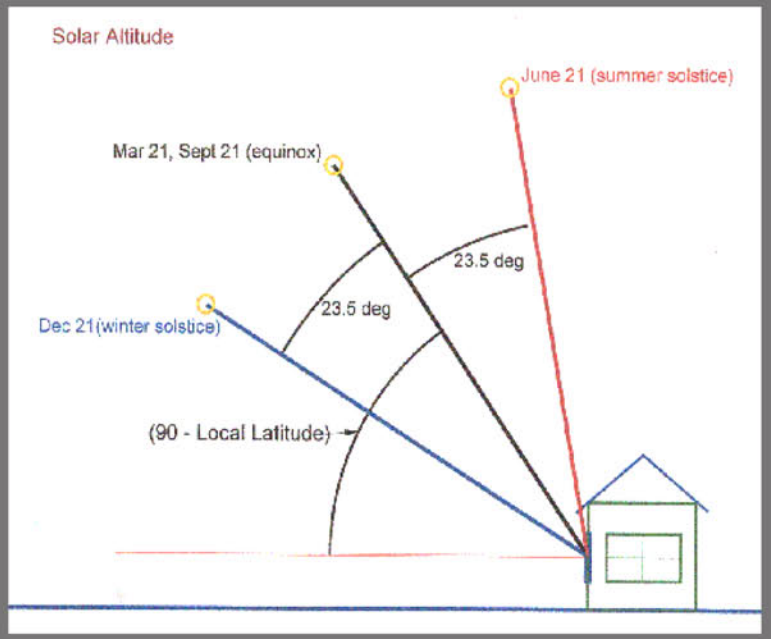
Regularly Occupied Spaces	Points
75%	1

LEED Guidance

As LEED was our basic guide for the monitoring of sustainability throughout the design process, every facet of design input had to contribute to achieving LEED certification through the achievement of points. By providing 75% of the required illuminance level with natural daylight a LEED point is gained.

top: Specific goals for illuminance levels are established to better guide design inputs throughout the daylighting analysis

right: Winter Solstice (25.72 degrees)
Equinox (49.22 degrees)
Summer Solstice (72.72 degrees)



Daylighting Directional Analysis

North -
Easiest to control - free of direct sunlight
Lowest solar gain - highest net heat loss

South -
Direct sunlight between Sept. 21 and March 21 - deep penetration of low angle Winter sunlight
High angle summer sunlight easy to control with overhang
High solar loads occur during coldest time of the year

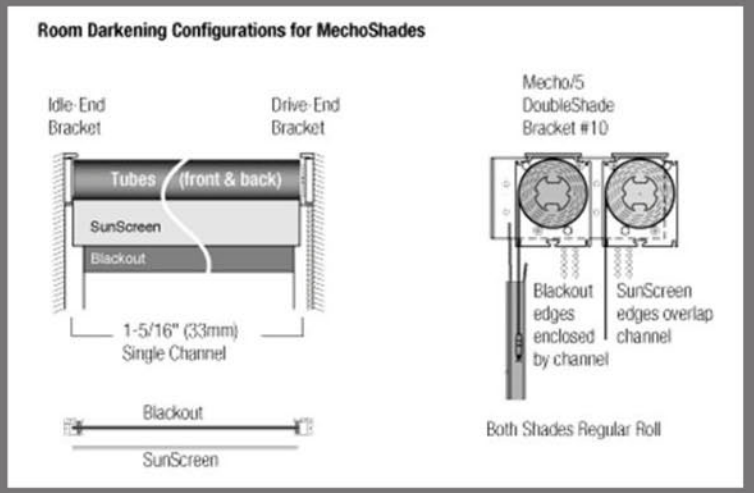
East / West -
East - low angle sunlight in morning with associated glare and solar gain
West - low angle sunlight in afternoon - worst case scenario for the cooling load

top: A view of a typical classroom overhang used to diffuse or block light from penetrating deep into the building

left: An example of the daylighting potential of a classroom via the use of clerestories

right: Window shades were decided upon as an accompanying system with overhangs and specific glazing applications

Window Shades



Project Vasari (Early Analysis)

Building Performance Factors

Location:	40.7848625183105,-77.8072357177734
Weather Station:	46792
Outdoor Temperature:	Max: 90°F/Min: -1°F
Floor Area:	58,356 sf
Exterior Wall Area:	44,962 sf
Average Lighting Power:	1.20 W/ft²
People:	1,355 people
Exterior Window Ratio:	0.41
Electrical Cost:	$0.10/kWh
Fuel Cost:	$1.41/Therm

4 Piped system with Chiller and Boiler

Life Cycle Electricity Use:	17,971,095 kWh
Life Cycle Fuel Use:	679,524 Therms
Life Cycle Energy Cost:	$1,215,596

*30-year life and 6.1% discount rate for costs

Central VAV

Life Cycle Electricity Use:	20,893,018 kWh
Life Cycle Fuel Use:	1,493,123 Therms
Life Cycle Energy Cost:	$1,863,971

*30-year life and 6.1% discount rate for costs

Mechanical Space Requirements

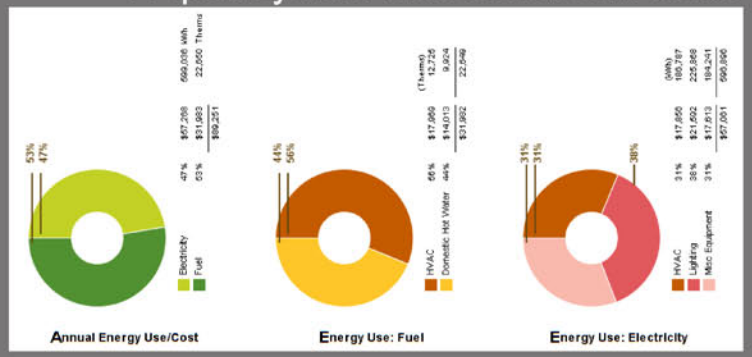
Approximately 2000sf -
Oversized for potential touring space as a learning tool

Mechanical Shaft -
Approximately 150sf

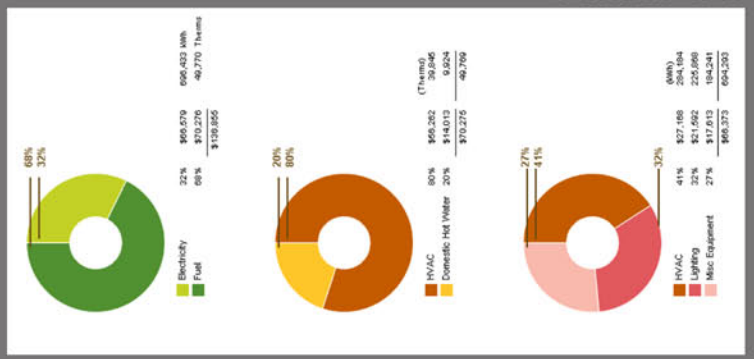
Below Floor -
Depeds on selected system

Displacement Ventilation -
Approximately 1sf

4 Piped system with Chiller and Boiler



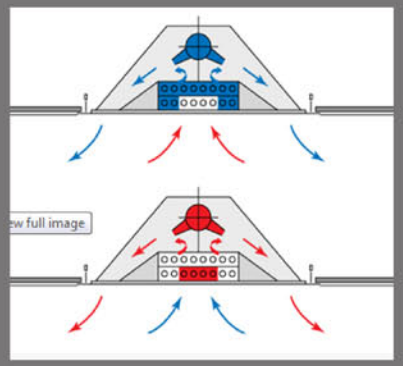
Central VAV

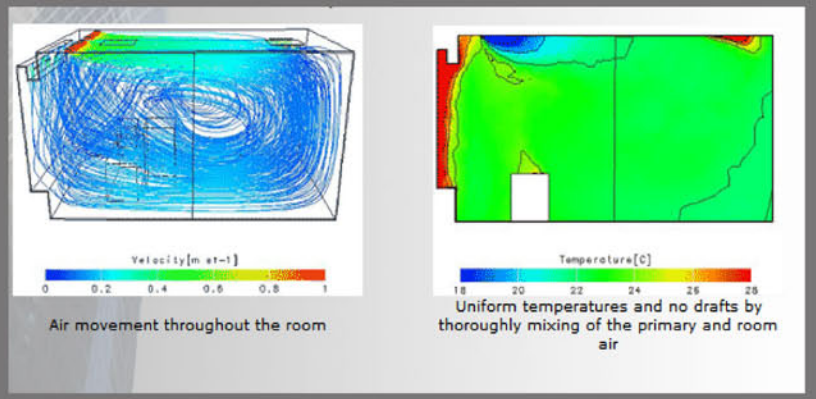


Chilled Beams

Advantages
Less ventilation required
Less fan energy used
Smaller duct sizes
Can utilize ground source heat pumps

Disadvantages
Humidity control (operable windows exacerbate this problem)
More piping required

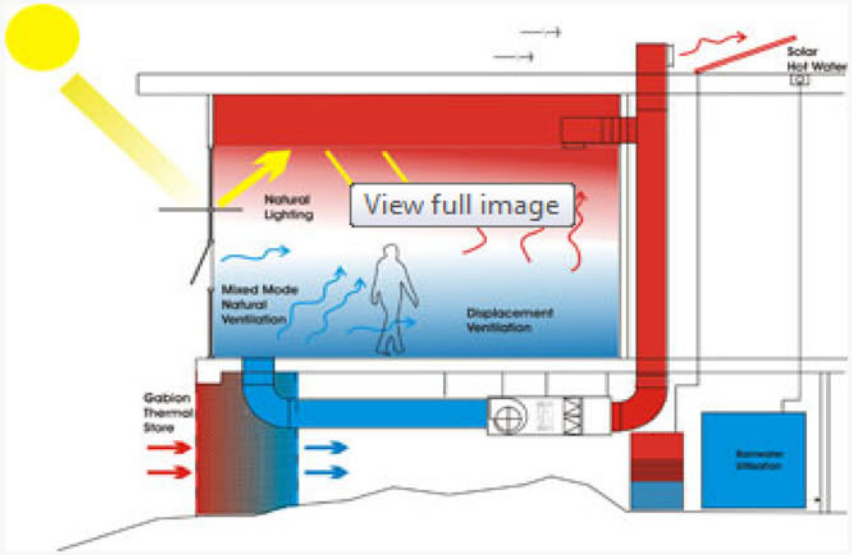




Air movement throughout the room

Uniform temperatures and no drafts by thoroughly mixing of the primary and room air

Displacement Ventilation

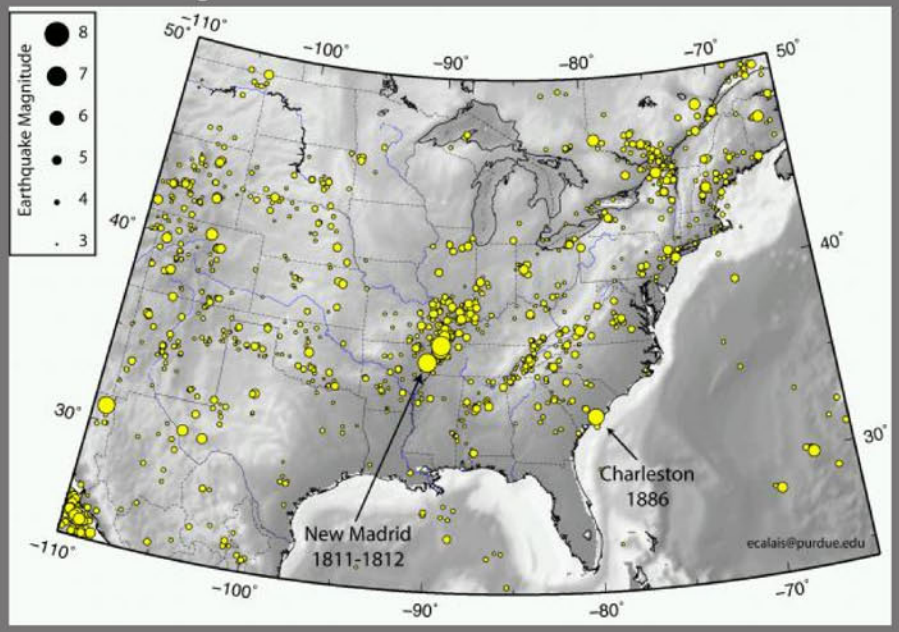


http://www.wahwvic.com.au/services_esd.html

Advantages
Better indoor air quality
Not required to ventilate entire space
Space can have a lower supply temperature in Winter

Disadvantages
Temperature stratification
Doesn't work well in spaces with high activity levels

Seismic Region



Calculated Snow Load

Structural Design Inputs

Sesimic -
Site Class D
SS=.150g
S1=.048g
SMS=0.24g
SM1= 0.115g

Snow -
Design for 30lbs / sq. ft.

Wind -
90mph
Risk Category = 3
Exposure Category = C
Open Terrain with Scattered Structures

Structural Options Advantages

Load Bearing Masonry -
Durable
Acoustically sound
Simple Construction
Thermal Massing

Concrete -
Thermal Massing
Short Lead Time
Small Staging Area
Fire Resistance
Low Maintenance

Structural Options Advantages

Heavy Timber -
Aesthetically Pleasing
Lightweight
Good Thermal Capacity

Steel Frame -
More Freedom for Arch. and LE
Fast Erection
Safe
Strong and Ductile
Can Cope with Settlements
Readily Available

http://www.mastermasonry.com/history2.htm

http://www.luxuryhousesdesign.com/design-architecture/concrete-building-by-junichi-sampei

http://www.gordonbelton.com/Projects/futureworld.html

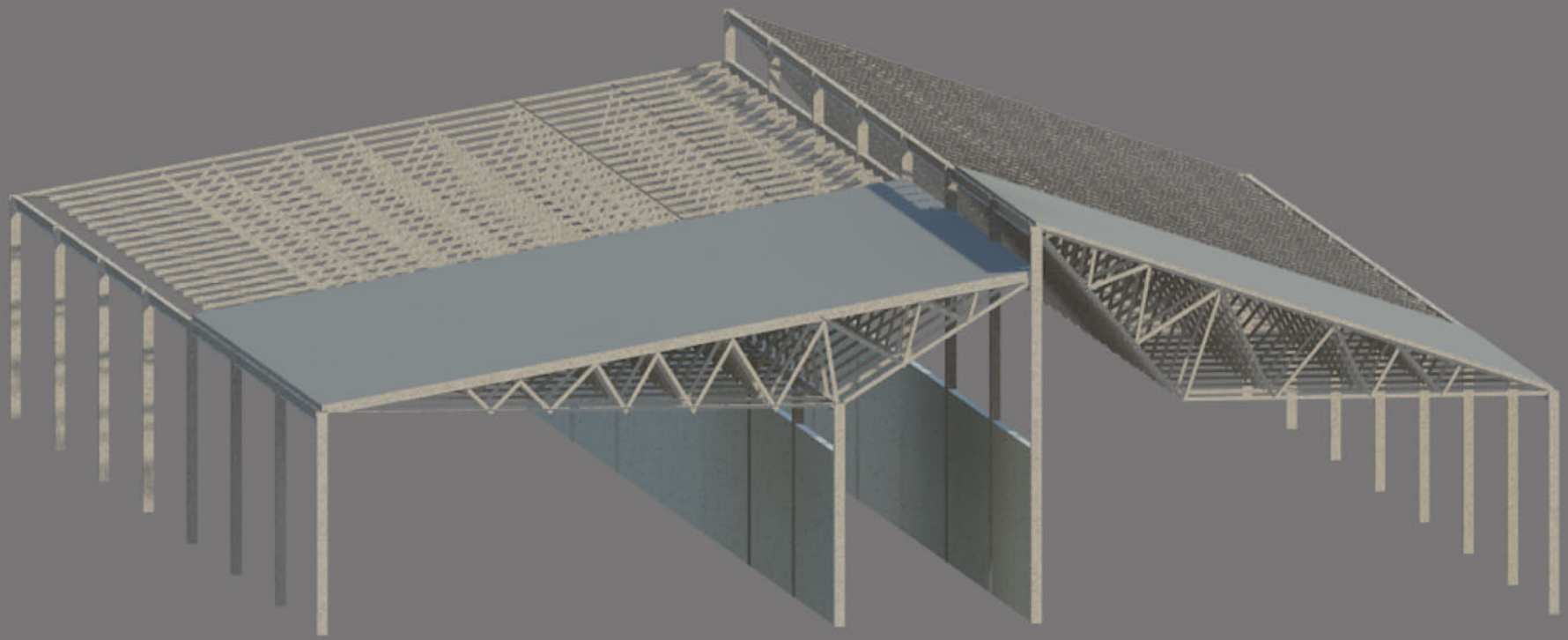
http://www.timberbydesign.com/timber-buildings/timber-frame-buildings.shtml

Schematic Structural Design

Structural Steel -
Wide Flange Girders and Columns
Inverted Trusses

Masonry -
Non- structural
Between all Columns
Load Bearing for Foundation

Cast-in-Place Concrete -
Stair Towers
Footings

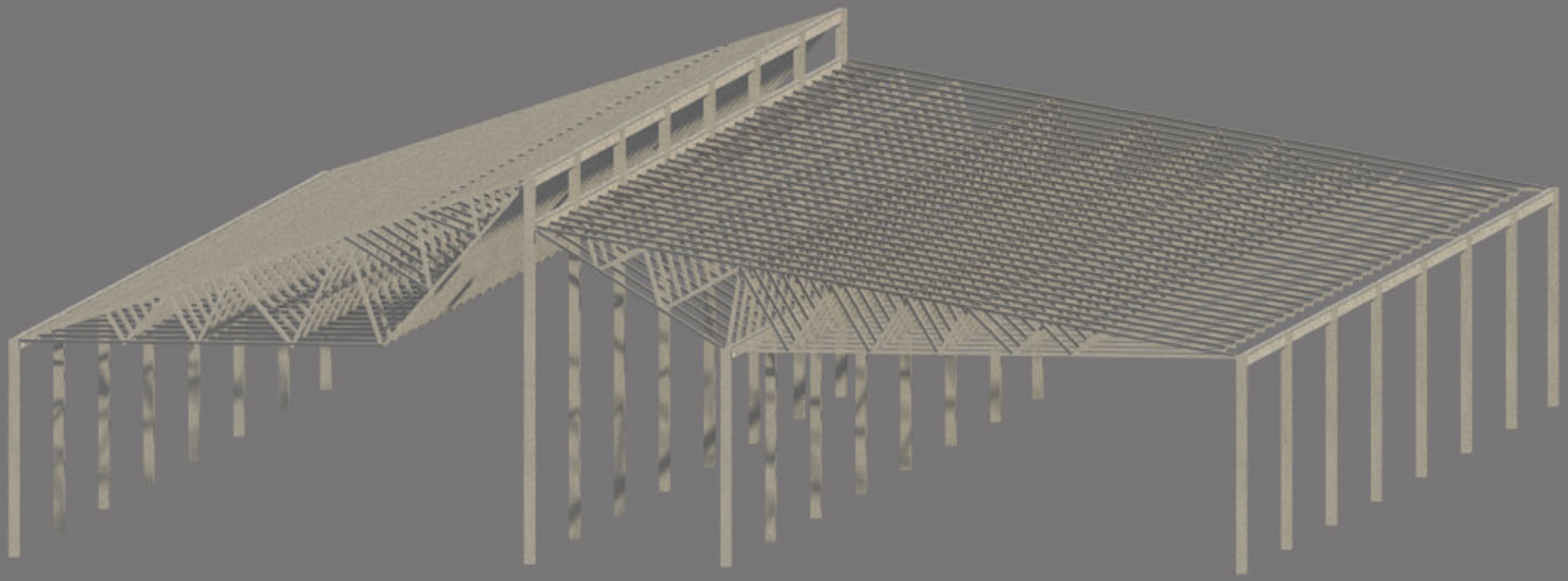


Initial Structural Analysis

Classroom Wing

Typical Bay -
42’ x 23’
W12 x 26 Girders
Inverted Trusses @ 5’ o.c.

Typical Roof -
1.5 F 22 Ga. Metal Roof Deck
3 Span Condition minimum

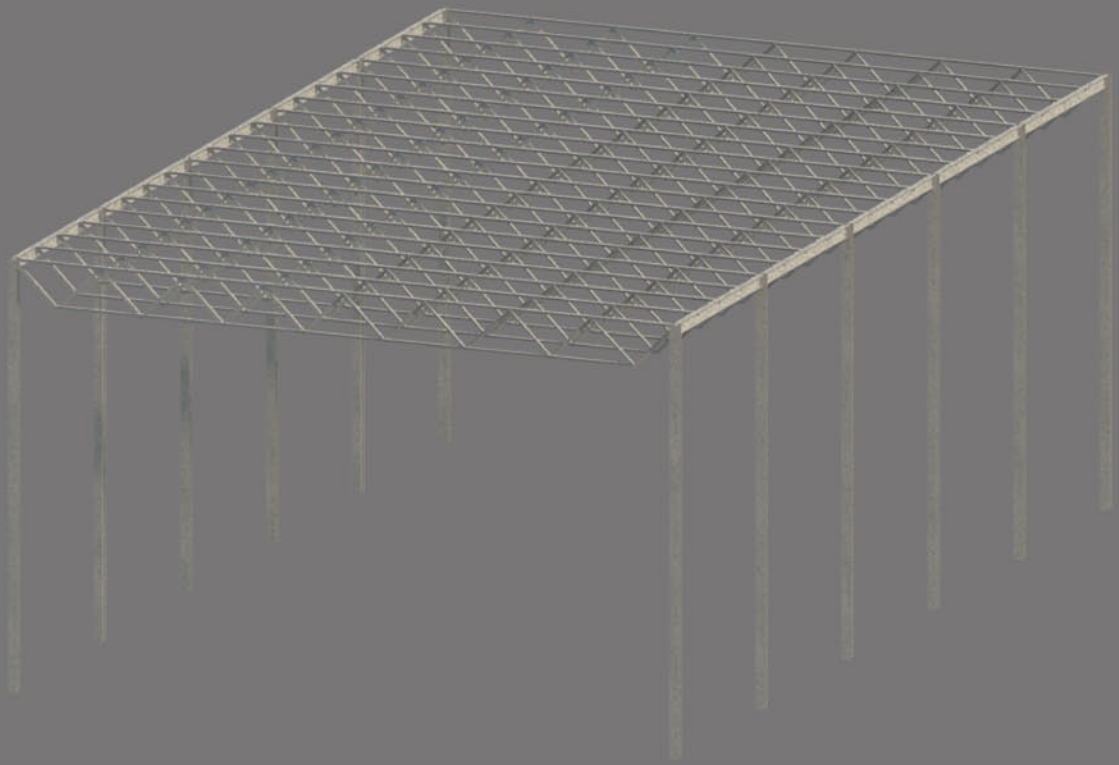


Initial Structural Analysis

Multi-purpose Space

Typical Bay -
20’ x 64’
W12 x 26 Girders
LH 10 @ 5’ o.c.

Typical Roof -
1.5 F 22 Ga. Metal Roof Deck
3 Span Condition minimum



ID	Task Mod	Task Name	Duration
1		**Design Schedule**	**76 days**
2		Start of Class	0 days
3		BIM EX Group Work	11 days
4		BIM EX Plan Presentation	0 days
5		Group Collaboration	9 days
6		Schematic Des. Presentation	0 days
7		Group Collaboration	16 days
8		DD Presentation	0 days
9		Group Collaboration	37 days
10		Final Presentation	0 days

Initial Progress Analysis

Collaborative delivery schedule
Completed 20 “work days” (4 weeks)
Design Schedule Remaining - 53 “work days”

38% Design Completion

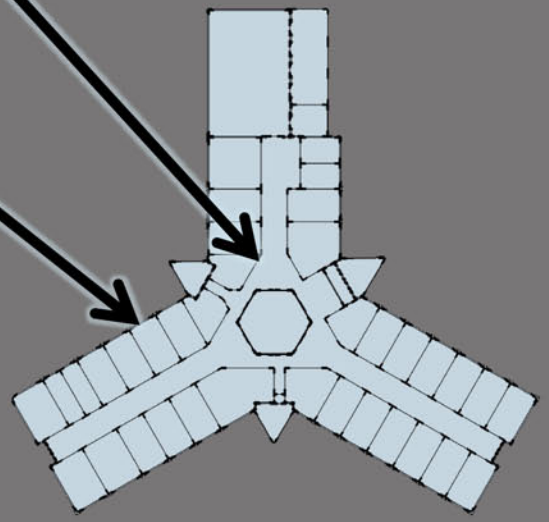
Steel Frame w/ Brick Exterior ($125/SF)	$7.3M
Common Additives	$0.1M
Geothermal System	$0.9M
Location Factor (0.87)	
Total Building Cost	**$7.2M**
O/H,Profit,Bonds,Insurance (10%)	**$ .72M**
Total Construction Cost:	**$7.9M**

Estimate

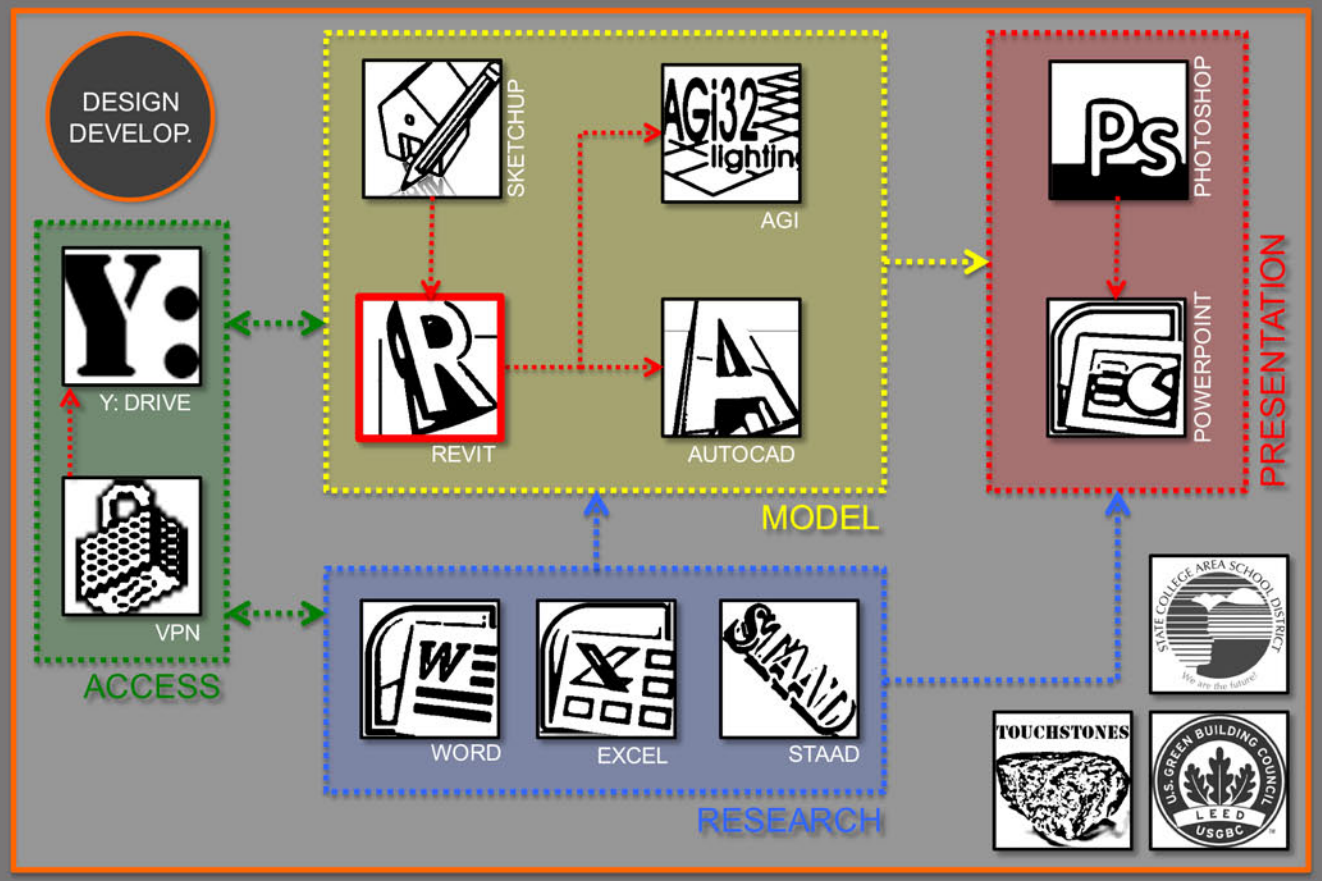
58,400 GSF

Face Brick/Steel Frame

1,330 LF



Data from RS Means M.560 Elementary Schools



Design Development

Architecture

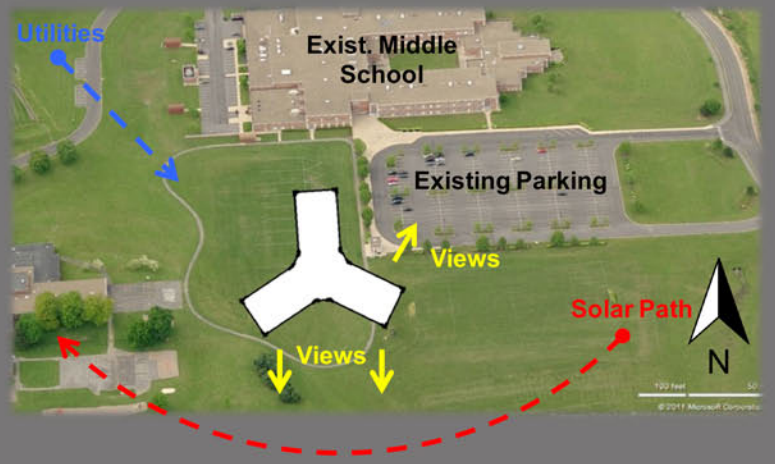
This phase of design pushed the floorplan even further where the spaces wer emuch more defined. THere was significant collaboration between structure, Mechanical, Lighting and Architecture to ensure all systems would work effectively together for optimized performance. The library was further developed into what would represent a “tree of knowledge” and include a tree house form for the library itself. The classrooms would become learning environments themselves in that all systems would be exposed (structure, mechanical, lighting, etc.). A greenroof began to develop as an outdoor learning tool. Also, a flex space was created to become a cafeteria during school hours and a gathering space for evening functions.

Construction

Continued development of cost estimation was completed by incorporating the newest iterations of building and site design. Site logistics were studied for construction access and order. Trailer locations and crane placements were also created. Continually updated schedules to keep team on track

Landscape Architecture

As design development progressed, programmed spaces were further detailed to better envelope the building with circulation patterns that were conducive to outdoor learning, gathering, teaching, and engaging. The stormwater system began to take shape and water collection became a goal through a collection of cisterns. Stormwater volume calculations were completed to establish a baseline figure for collection and purification for potable water generation.



Lighting / Electrical

Daylighting and electrical studies of a typical classroom were done using AGI. This yielded the appropriate fixtures to meet illuminance requirements that maintained our commitment to energy efficiency. Photo and occupancy sensors were studied for optimum placement within the commonly occupied spaces (i.e. office and classrooms). Also completed was the digital modeling of the chosen light fixtures within the central Revit file. The final energy figures were communicated to the Mechanical engineer for energy model analysis.

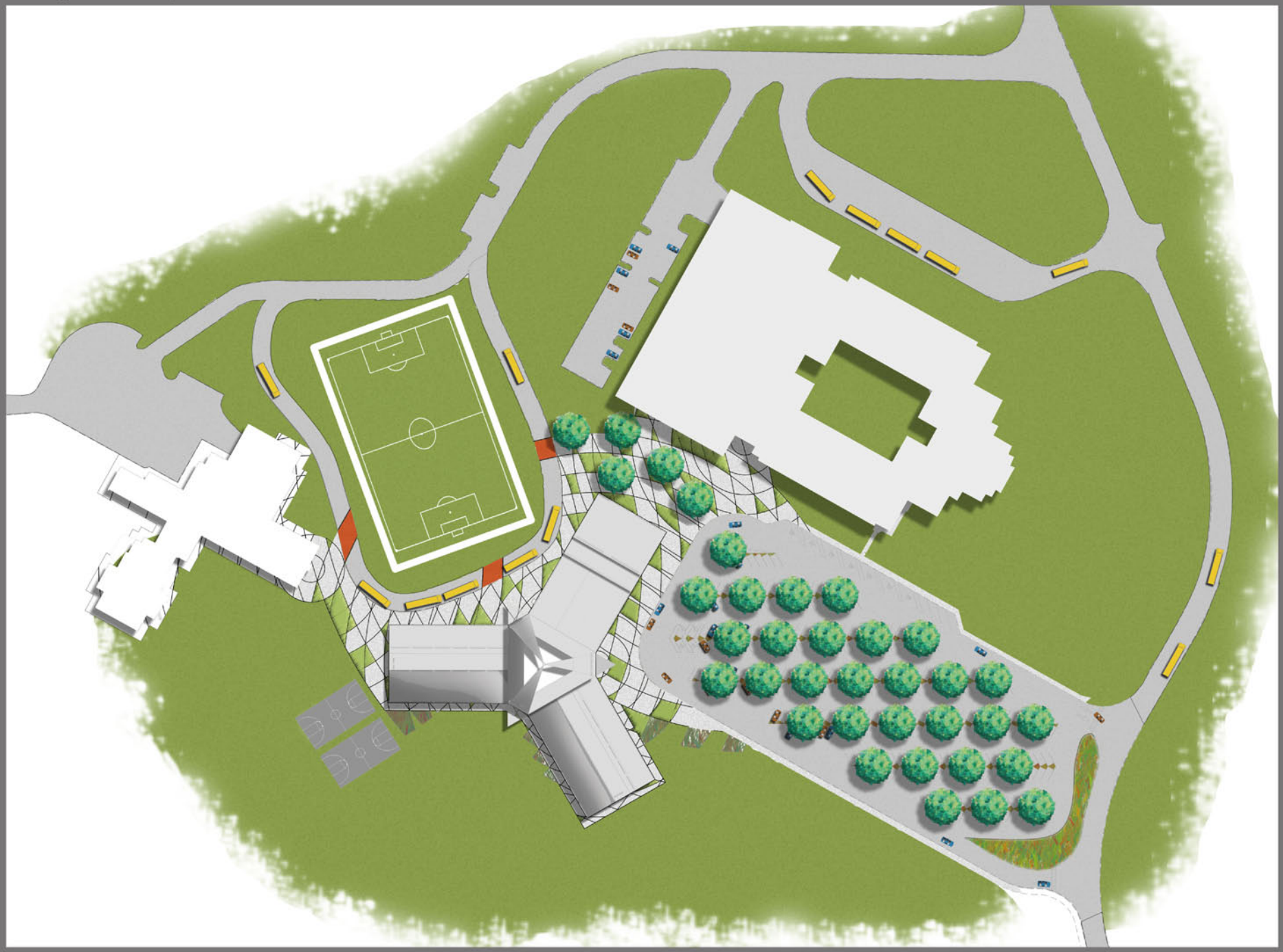
Mechanical

Design development brought with it our systems selection process. Working closely with each discipline yielded a list of pros and cons to each system. Evaluation of this list generated a clear-cut decision that exceeded the needs of each field while maintaining our goal of energy efficiency. Individual ground source heat pumps in each room served by a dedicated outdoor air system with an energy recovery ventilator. This combination of systems allows for individual room control, reduced fan energy, energy recovery, and a well integrated design that worked well with other disciplines design ideas.

Structural

The Revit model was further developed to provide a better visual aid for building design critiques with each member of the group. The most appropriate structural system was chosen for the most current design iteration of the building. As floor plans were close to finalization, a schematic structural system was sized and laid out for the classroom wings and the multi-purpose space. Clash detection was done to minimize miscommunications between mechanical and structural systems. Structural systems were explored for the greenroof and the developing flex space.

Design Development Master Plan

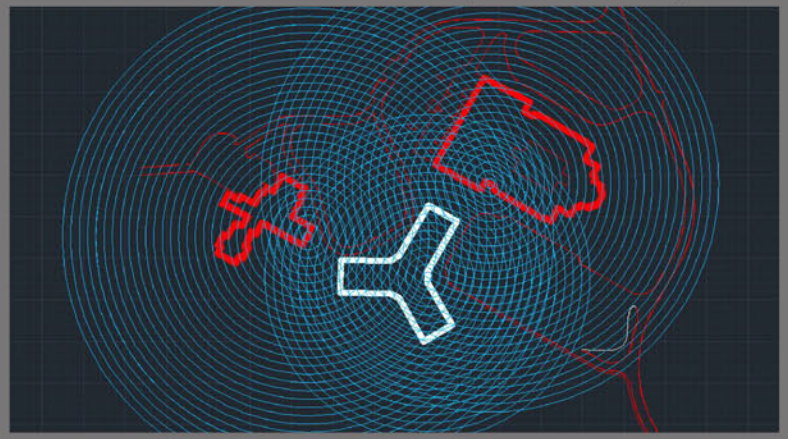


LEED Tracking for Sustainability

Sustainable Sites:

Prereq. 1 – Construction Activity Pollution Prevent.	Req.
Credit 1 – Site Selection	1 point
Credit 4.2 – Alt. Trans. Bike/changing rooms	1 point
Credit 4.3 – Alt. Trans: Fuel-Efficient Vehicles	3 points
Credit 4.4 – Alt. Trans: Parking Capacity	2 points
Credit 5.1 – Site Develop: Protect/restore Habitat	1 point
Credit 5.2 – Site Develop: Maximize Open Space	1 point
Credit 6.1 – Stormwater Design – Quantity Control	1 point
Credit 6.2 – Stormwater Design – Quality Control	1 point
Credit 7.1 – Heat Island Effect – Nonroof	1 point
Credit 7.2 – Heat Island Effect – Roof	1 point
Credit 8 – Light Pollution Reduction	1 point
TOTAL LEED POINTS:	**14 points**

Conceptual Development



CURRENT LEED TOTAL: 14 POINTS

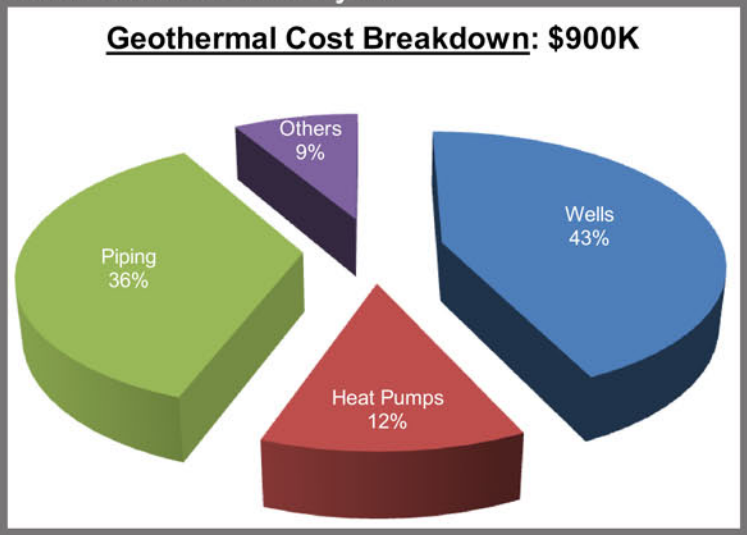
Initial Progress Analysis

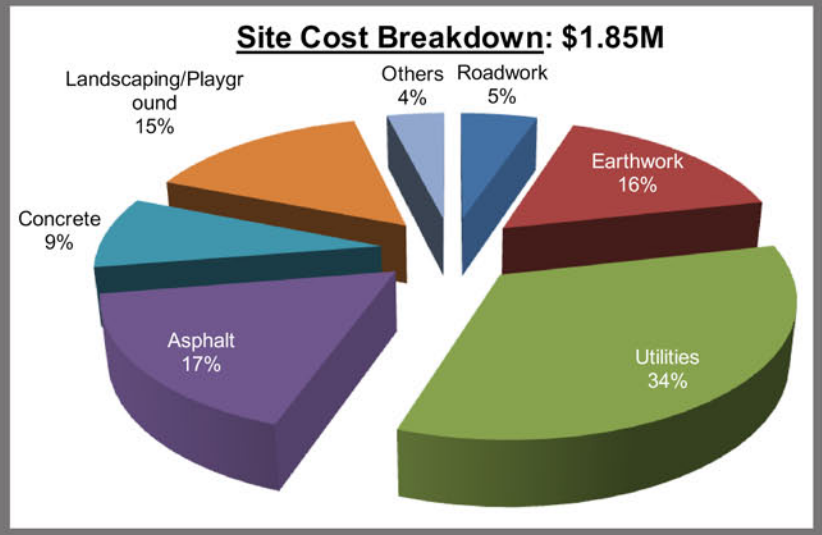
Collaborative delivery schedule
Completed 20 “work days” (4 weeks)
Design Schedule Remaining - 53 “work days”

38% Design Completion

Entry Drive Perspective

Initial Site Cost Analysis





Main Entrance

Focal Point of Entry

As the center of learning, the library takes focal precedence as you enter the building.

The administration office on your right as you enter serves as a security protocol as well.

A second set of doors will create a vestibul that will remain locked after school has commenced so any visitor must pass through the office in order to enter the school.

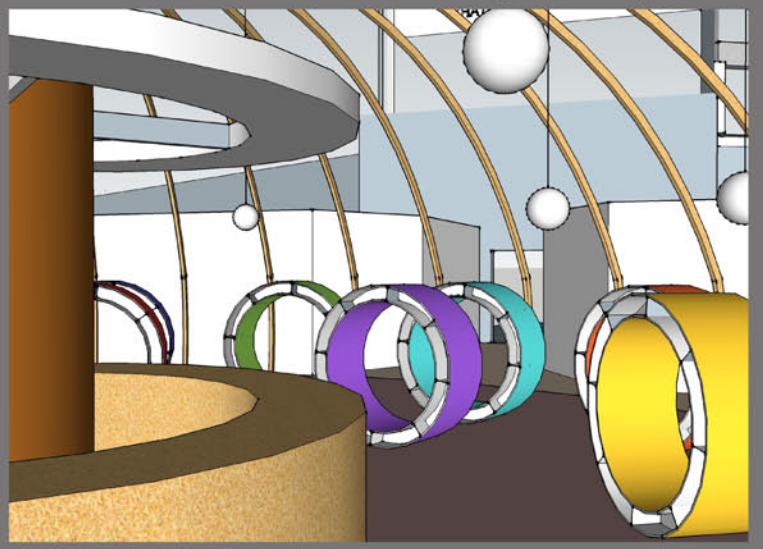
Library Development

Playing with Planes

The circular book shelves provide an interesting change of visual plane while serving a purpose within the library. Scaling them down a bit from the image on the immediate right it is easy to see how much fun they could be to interact with.

The mobiles hanging between the skylights and the library will diffuse and dapple light to provide the effect of being in or under a tree canopy.

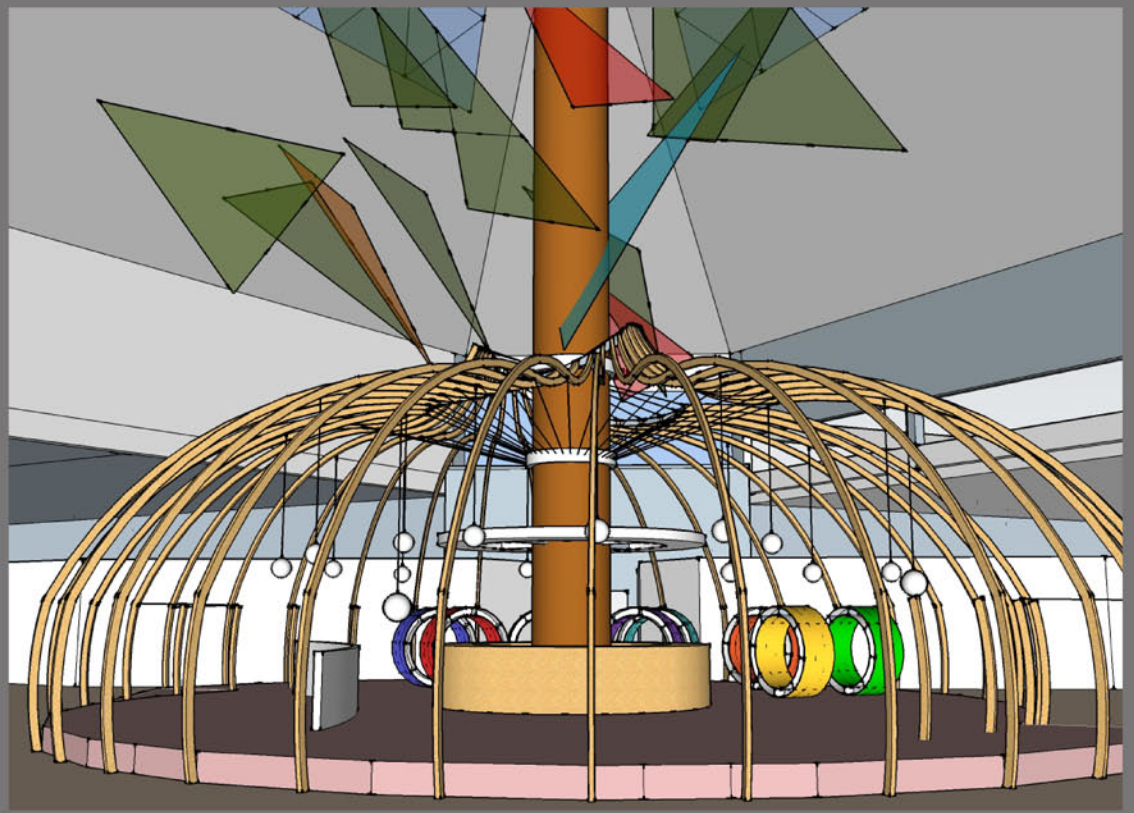
http://www.mecho.com.au/wp-includes/images/david-garcia-circular-bookcase-archive-8-1.jpg



top right: The hanging globe lights help to emphasize the idea of being outside with fireflies or in a treehouse with lanterns

below: Playing with illumination and organization can also help to create a reading oasis in the middle of a classroom

http://media.bestofmicro.com/thomas-mills-circular-bookshelf,E-R-270099-13.jpg



LEED Tracking for Sustainability

Materials and Resources:

Prereq. 1 – Storage and Collection of Recyclables	Req.
Credit 2 – Construction Waste Management	1-2 pts.
Credit 3 – Materials Reuse	1-2 pts.
Credit 4 – Recycled Content	1-2 pts.
Credit 5 – Regional Materials	1-2 pts.
Credit 7 – Certified Wood	1 point
TOTAL LEED POINTS:	**7 points**

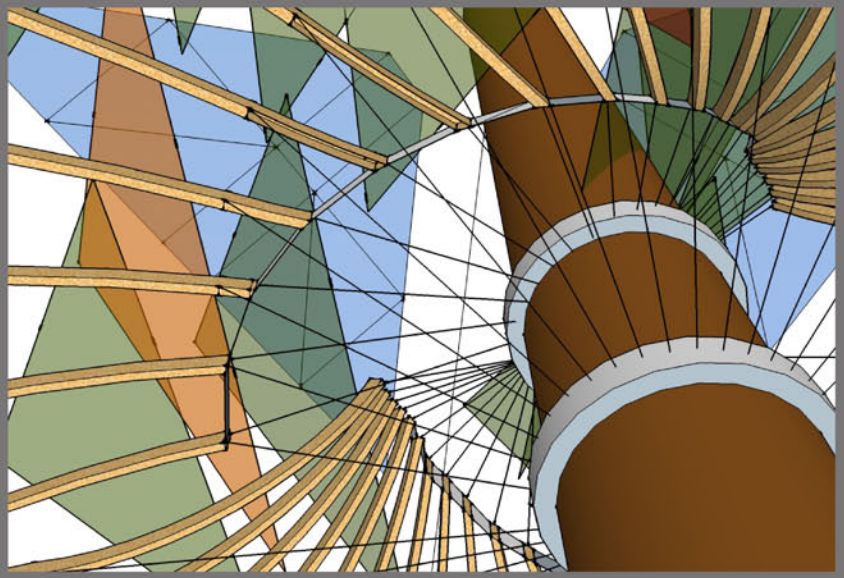
CURRENT LEED TOTAL: 21 POINTS


Tree house Restaurant, New Zealand

http://www.treehugger.com/files/2009/03/treehouse_resta.php

Studying in a Treehouse

Emphasizing the communities outcry for a more environmentally engaging learning environment we designed for children to study in the atmosphere of a treehouse.



top: Exterior view of the restaurant inspiration

left: The dappled light coming from the mobiles help to create a feeling of being within a treehouse

right: Interior image of the inspiring treehouse restaurant


Tree house Restaurant, New Zealand

Super Column Structure

The super column provides a center for the "tree" in the middle of the library.

This will provide an open plane throughout the library by supporting the triangular roof structure as it sits at the acme of the roof between the skylights.

Program Comparison

Library:

Required:	1 @ 2,000 SF
Actual:	1 @ 2,100 SF

Administrative Offices:

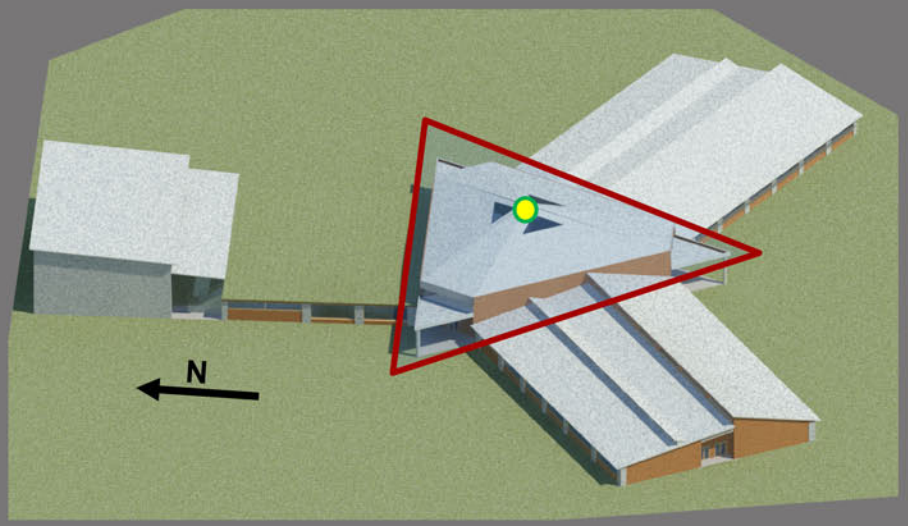
Required:	1 @ 1,500 SF
Actual:	1 @ 1,435 SF

Nurse's Suite:

Required:	1 @ 900 SF
Actual:	1 @ 930 SF

Faculty Lunch/Work:

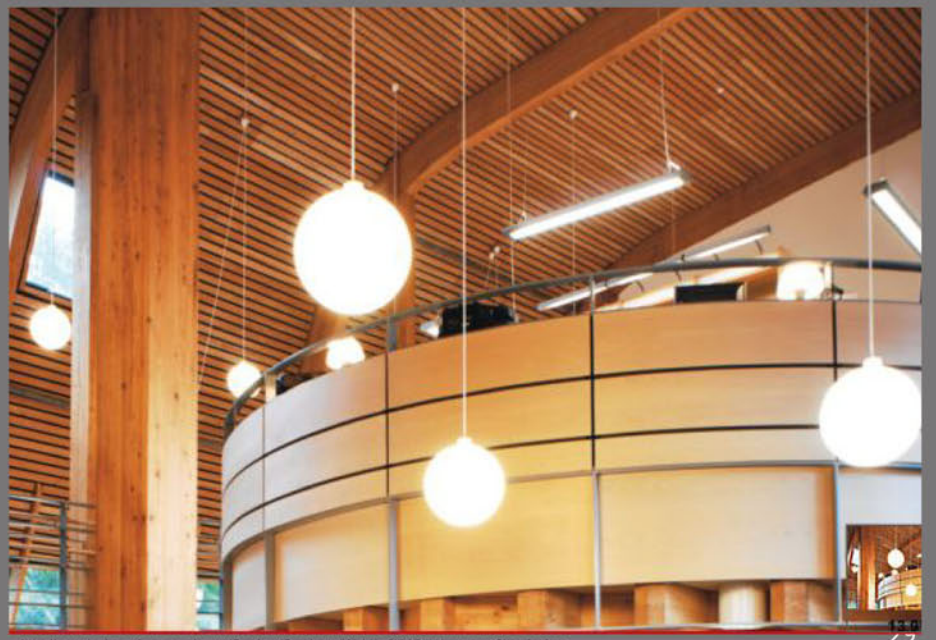
Required:	1 @ 800 SF
Actual:	1 @ 1,175 SF



top: Super column construction

left: Central construction aids in an open floor plan

below: Lighting examples to help offset the diffused light coming through the skylights



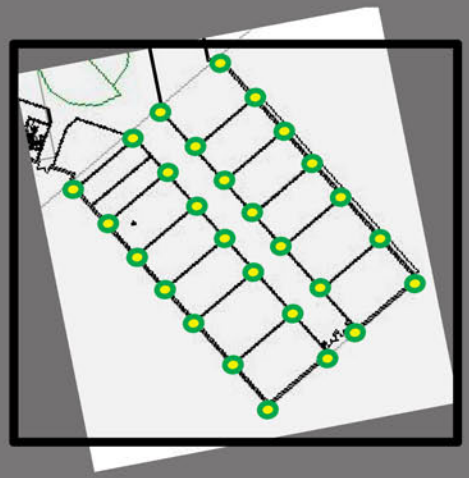
http://www.louispoulsen.com/en-us/Product/Pendants/Wohlert%20Pendant.aspx?Inspiration

Indoor Environmental Quality:

Prereq. 1 – Min. Indoor Air Quality Performance	Req.
Prereq. 2 – ETS Control	Req.
Credit 1 – Outdoor Air Delivery Monitoring	1 point
Credit 2 – Increased Ventilation	1 point
Credit 3.1 – Const. IAQ Mgmt. Plan (During Const.)	1 point
Credit 3.2 – Const. IAQ Mgmt. Plan (Before Occ.)	1 point
Credit 4.1 – Low-E Materials – Adhesives/Sealants	1 point
Credit 4.2 – Low-E Materials – Paints/Coatings	1 point
Credit 4.3 – Low-E Materials – Flooring Systems	1 point
Credit 4.4 – Low-E Materials – Composite Wood	1 point
Credit 5 – Indoor Chemical & Pollutant Source Cont.	1 point
Credit 6.1 – Controllability of Syst. – Lighting	1 point
Credit 6.2 – Controllability of Syst. – Thermal Comfort	1 point
Credit 7.1 – Thermal Comfort – Design	1 point
Credit 7.2 – Thermal Comfort – Verification	1 point
Credit 8.1 – Daylight and Views – Daylight	1 point
Credit 8.2 – Daylight and Views – Views	1 point
TOTAL LEED POINTS:	**15 points**

Why Structural Steel

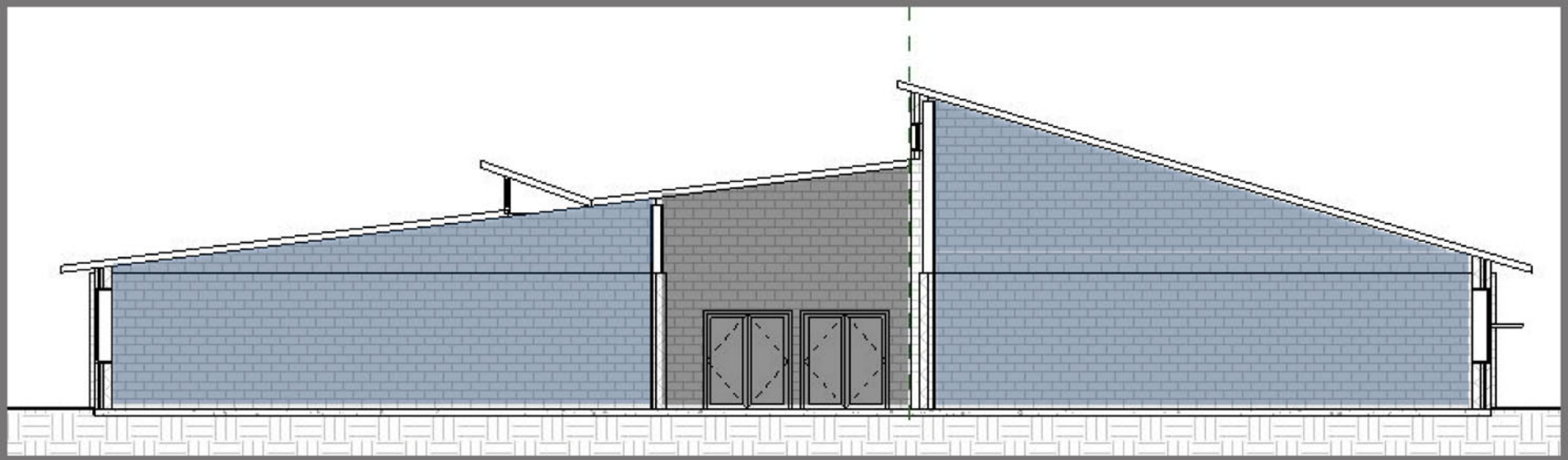
Largest Spans
More Flexibility
Fewer Intrusions



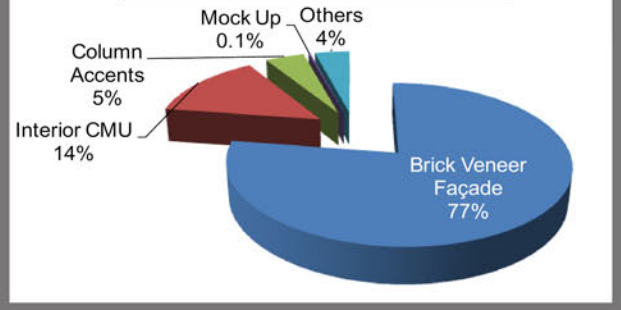
right: Structural steel column layout for a classroom wing

below: A section of a classroom wing demonstrating the roof slope and layout of the clerestories for daylighting

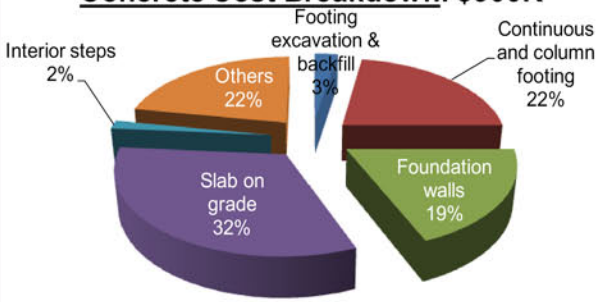
CURRENT LEED TOTAL: 36 POINTS



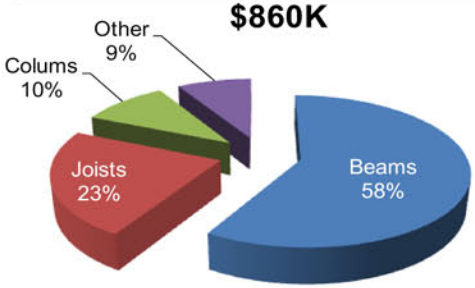
Masonry Cost Breakdown: $1M

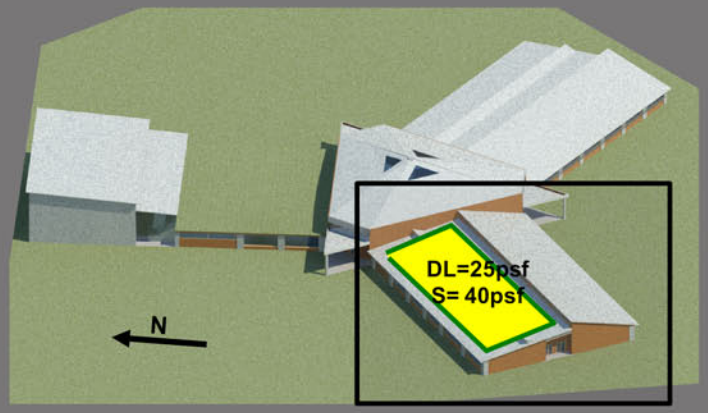


Concrete Cost Breakdown: $900K



Structural Steel Cost Breakdown: $860K

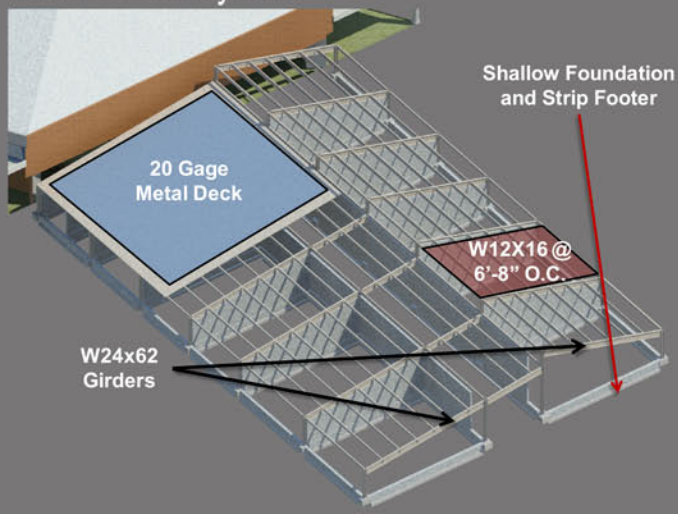




Strip Footers/Shallow Foundation

Sink hole potential

Conventional System

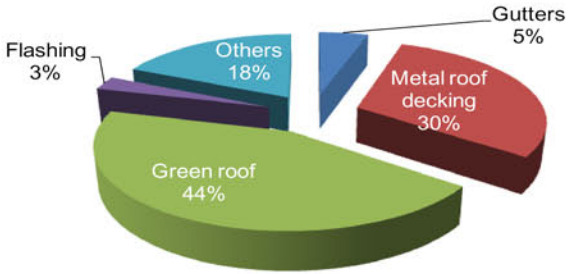


top: Pie chart depictions of current cost breakdowns

left: Structural analysis of current layout

immediately above: An example of exposed structural systems with a clerestory

Roofing Cost Breakdown: $750K



Classrooms:

Required:	18 @ 900 SF = 16,200 SF
Actual:	18 @ 920 SF = 16,620 SF

Kindergarten Rooms:

Required:	3 @ 1,100 SF = 3,300 SF
Actual:	3 @ 1,130 SF = 3,390 SF

Small Group Instruction:

Required	3 @ 440 SF = 1,320 SF
Actual:	3 @ 615 SF = 1,850 SF

Art Room:

Required:	1 @ 1,000 SF
Actual:	1 @ 1,100 SF

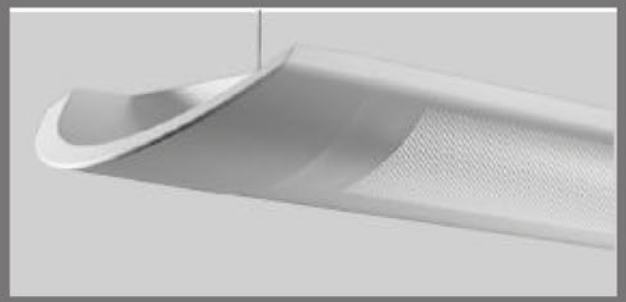
http://www.americansouthgc.com/project_portfolio_view_images.cfm?id=25

left: An example of clerestories for daylighting of interior spaces

right: florescent lights on occupancy and photo sensors will line the ceilings of each classroom

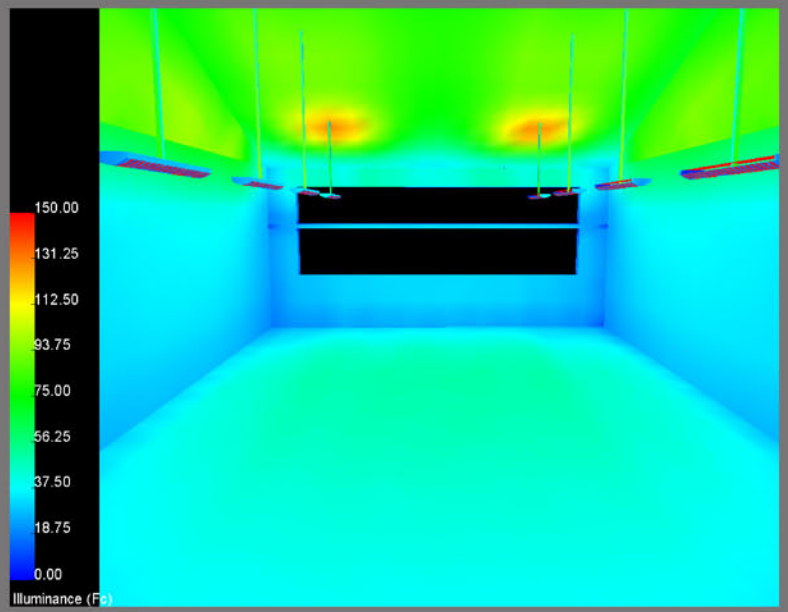
bottom left: An illuminance study of a typical classroom with a perpendicular light arrangement

bottom right: Eyebrows in front of the glazing help to reduce glare and direct overhead sun light penetration into the interior spaces

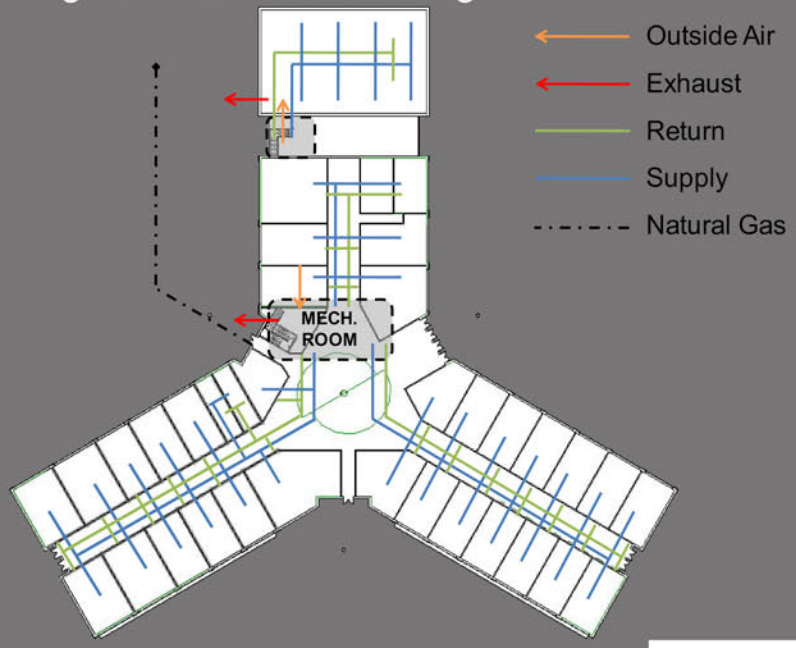


Daylighting

Taking advantage of the southern exposure, much of the light needed throughout the building can be achieved through daylighting techniques combined with minimal electric lighting to meet illuminance requirements



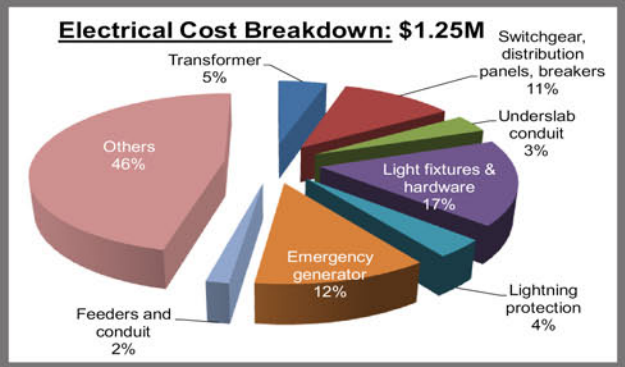
Single Line Distribution Diagram



Energy and Atmosphere:

Prereq. 1 – Fund. Commish of Build. Energy Syst.	Req.
Prereq. 2 – Minimum Energy Performance	Req.
Prereq. 3 – Fundamental Refrigerant Management	Req.
Credit 1 – Optimize Energy Performance	1-19 pts
Credit 2 – On-site Renewable Energy	1-7 pts.
Credit 3 – Enhanced Commissioning	2 points
Credit 4 – Enhanced Refrigerant Management	2 points
Credit 5 – Measurement and Verification	3 points
Credit 6 – Green Power	2 points
TOTAL LEED POINTS:	**21 points**

CURRENT LEED TOTAL: 57 POINTS

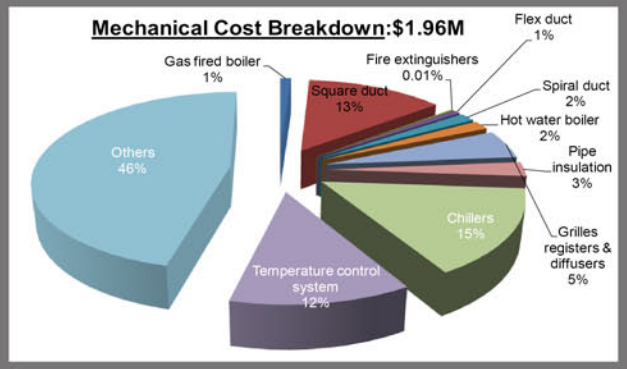


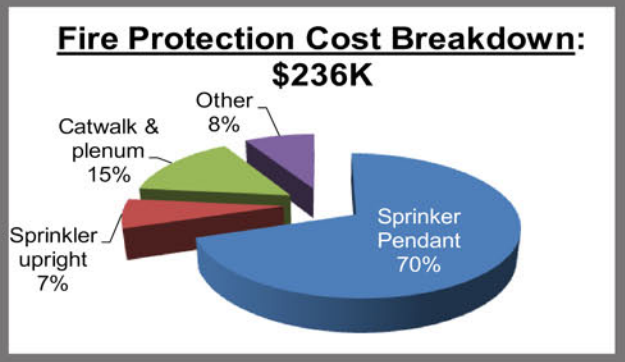
Mechanical Space:

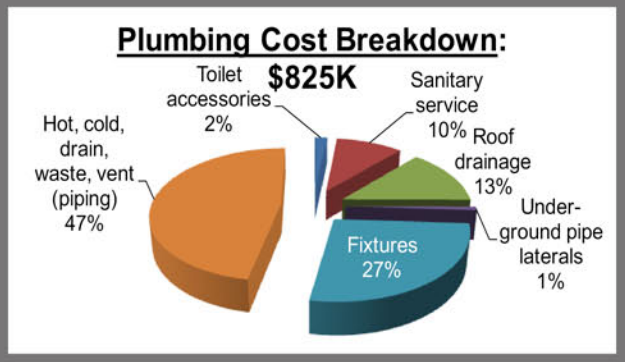
Required: 1 @ 1500 SF (system dependant)
Actual: 1 @ 2100 SF (for tours)

Restrooms:

Required: 4 @ 450 SF = 1,800 SF
Actual: 4 @ 590 SF = 2,370 SF







Water Efficiency:

Prerequisite 1 – Water Use Reduction	Req.
Credit 1 – Water Efficient Landscaping	2-4 pts.
Credit 2 – Innovative Wastewater Tech.	2 points
Credit 3 – Water Use Reduction	2-4 pts.
TOTAL LEED POINTS:	**8 points**

Water Importance

Water reduction is a beneficial sustainability measure so collection and purification of water collected on site could ultimately prove to gain needed LEED credits.

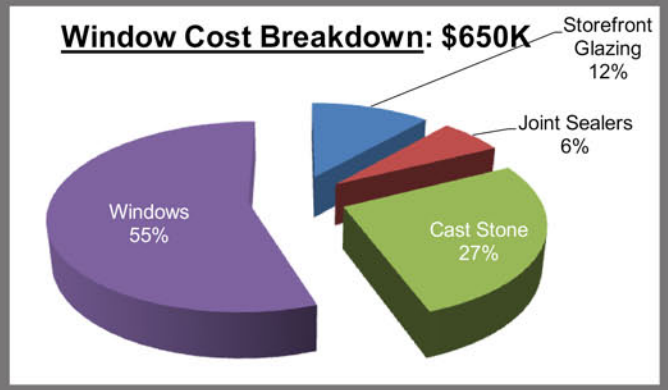
Music Room:

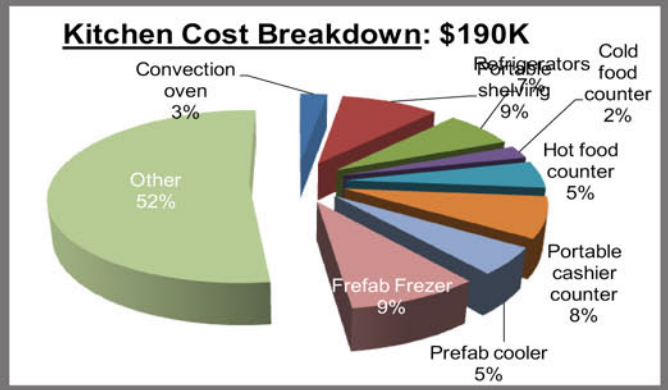
Required:	1 @ 900 SF
Actual:	1 @ 1,000 SF

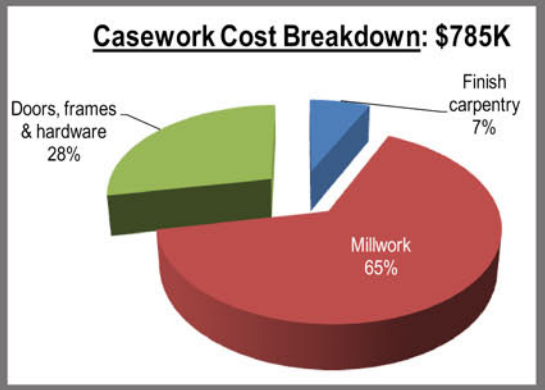
Instrumental Music Room:

Required:	1 @ 1,000 SF
Actual:	1 @ 1,000 SF

CURRENT LEED TOTAL: 65 POINTS

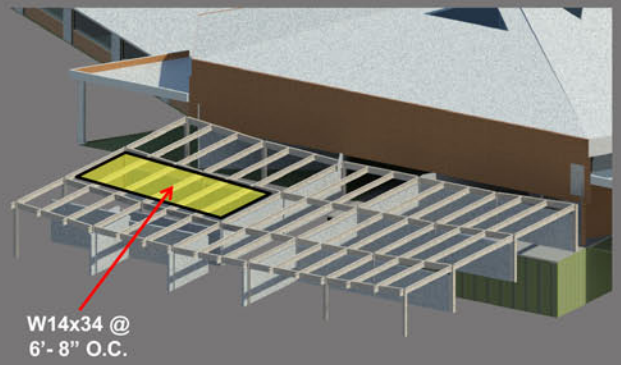




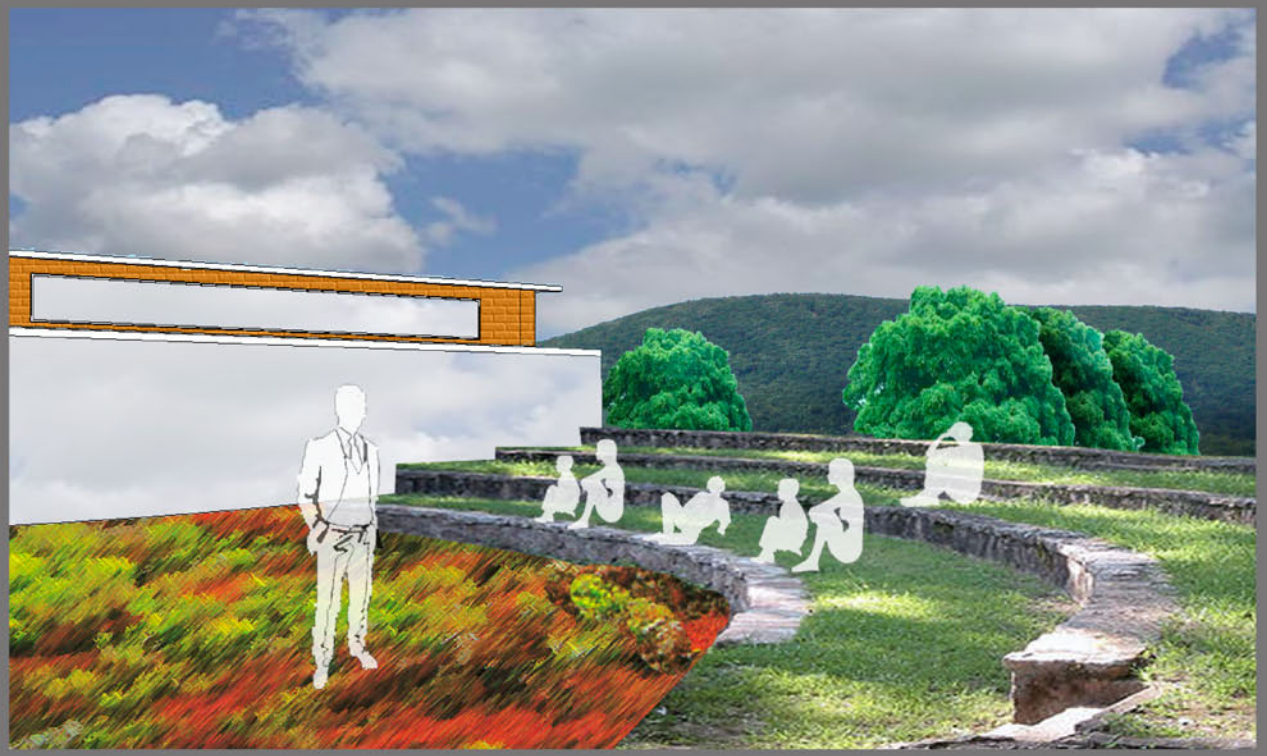


	Unit Ventilator w/ GSHP	Active Chilled Beams with GSHP	VAV system with an Economizer	Individual GSHP with dedicated Outdoor Air
Load (cooling/heating)	1,161,675 / 461,060	1,161,675 / 461,060	1,161,675 / 461,060	1,161,675 / 461,060
Volumetric Flow Rate	17,800	17,800	43,000	17,800
Heat Recovery	🔴	🟢	🟢	🟢
Low Fan Energy	🟢	🟢	🔴	🟢
Cost				
Individual Controllability	🟢	🟢	🔴	🟢
Opportunity to use Mech as a learning tool	🔴	🟡	🟢	🟢

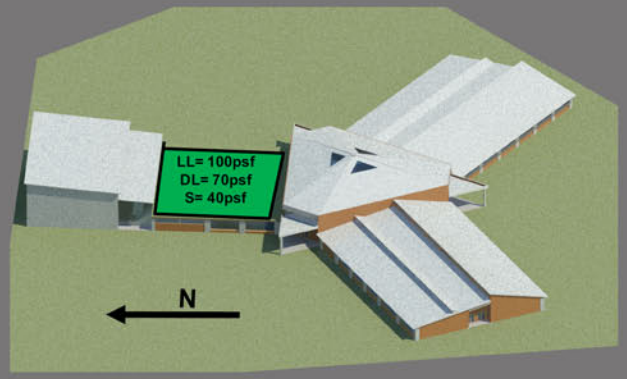
below: An example of a curving greenroof that is a prime example of the structure we would like to create



- Spaced Columns Closer
- Shorter Spans
- Custom Shaped Girders



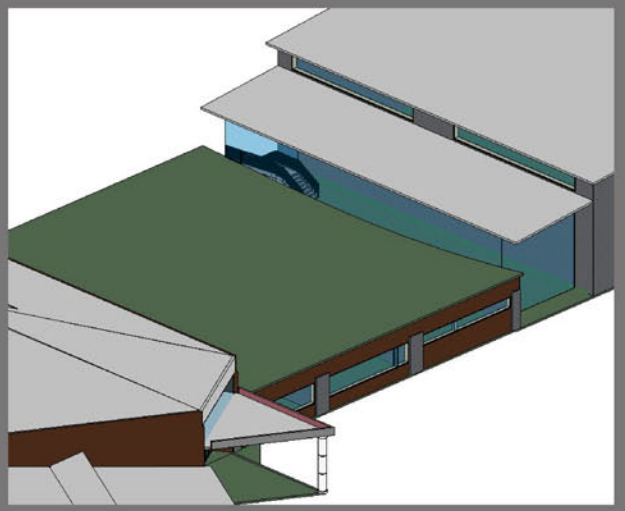
above: This conceptual greenroof classroom would be a wonderful escape from the typical classroom experience where engaging learning tools are only a glance away

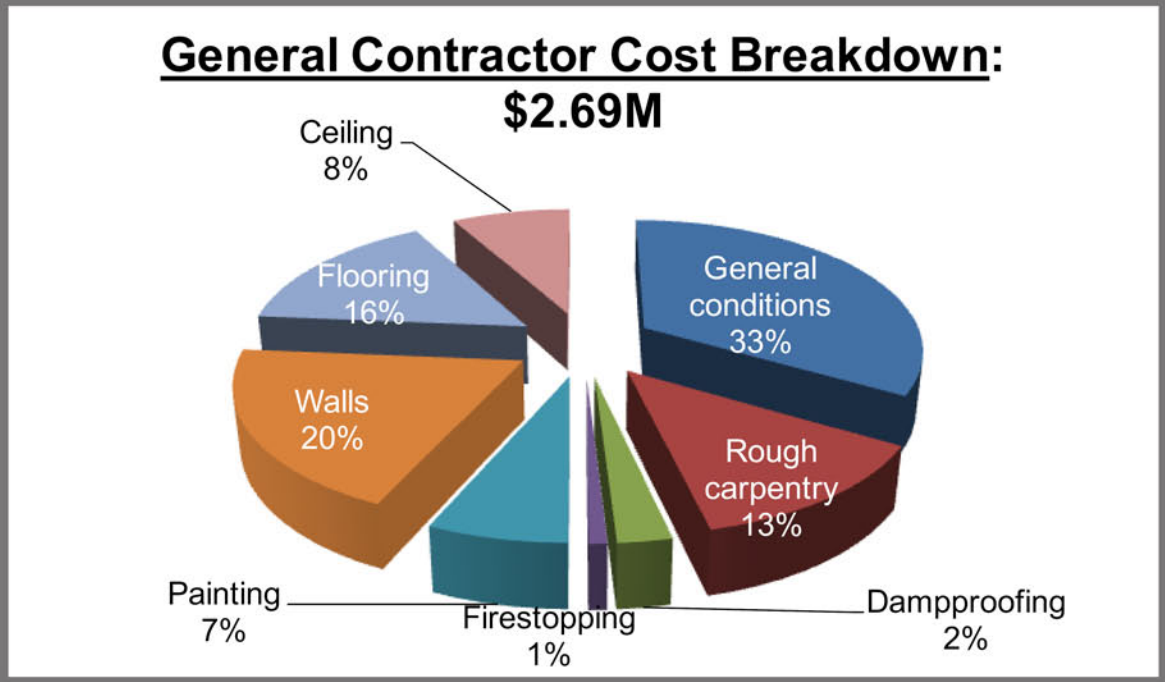


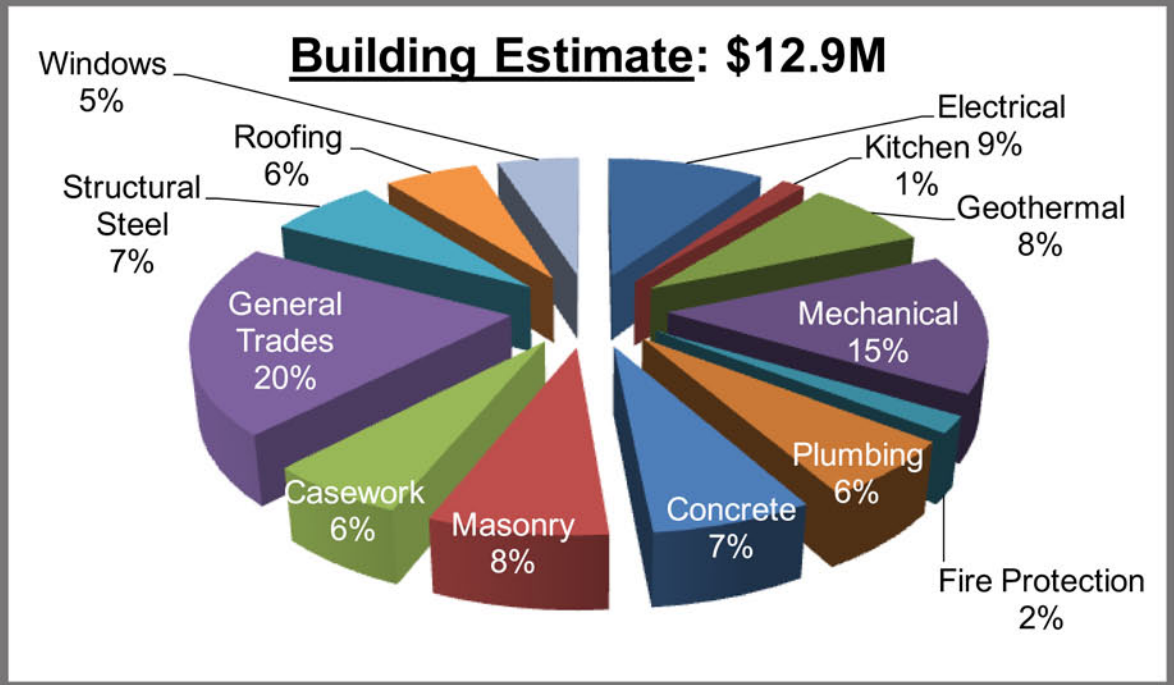
top: Unique spacing and load calculations had to be conducted in order to ensure structural stability of the heavy green roof

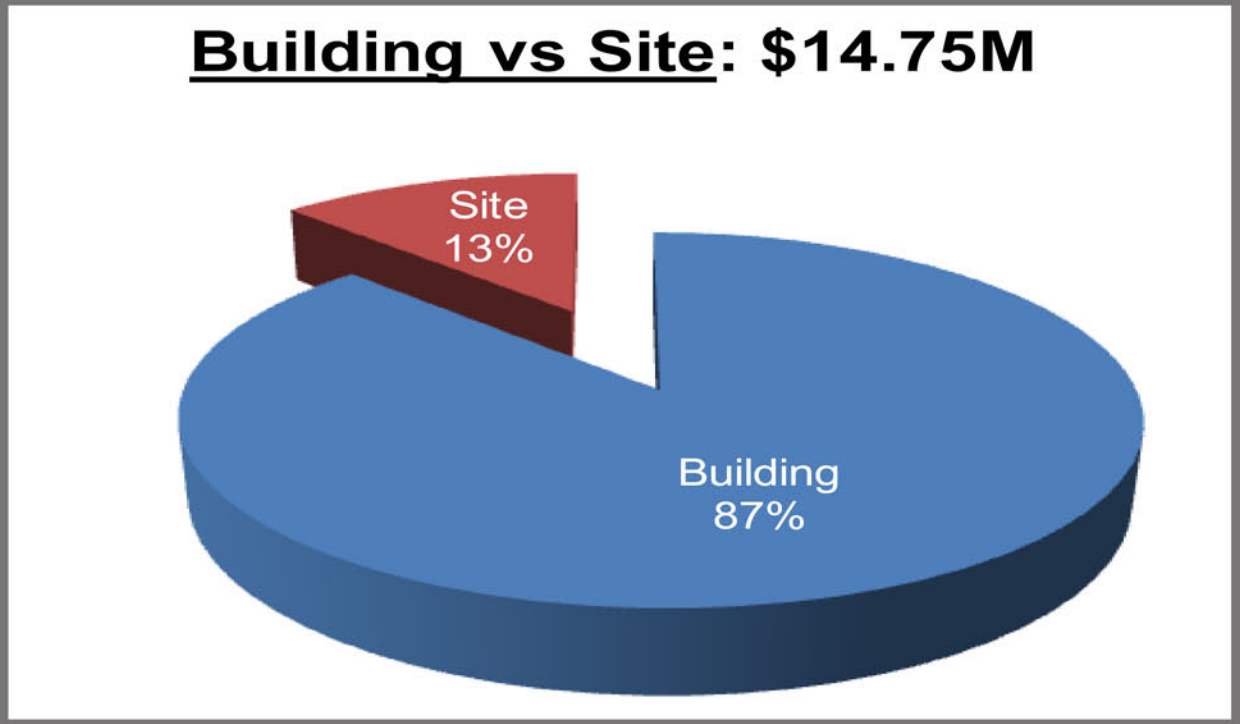
Greenroof Design

Another advantage of our building's location is our beautiful ridge and valley system. This is exemplified by Mount Nittany and the Tussey Ridgeline. Taking advantage of the viewsheds and the elevation of our roof for plantings in an educational environment could be a wonderful space for learning.




General Contractor Cost Breakdown:
$2.69M
Ceiling 8%
Flooring 16%
Walls 20%
Painting 7%
Firestopping 1%
Dampproofing 2%
Rough carpentry 13%
General conditions 33%


Building Estimate: $12.9M
Windows 5%
Roofing 6%
Structural Steel 7%
General Trades 20%
Casework 6%
Masonry 8%
Concrete 7%
Plumbing 6%
Fire Protection 2%
Mechanical 15%
Geothermal 8%
Kitchen 9%
Electrical 1%



Cost-Effective Design

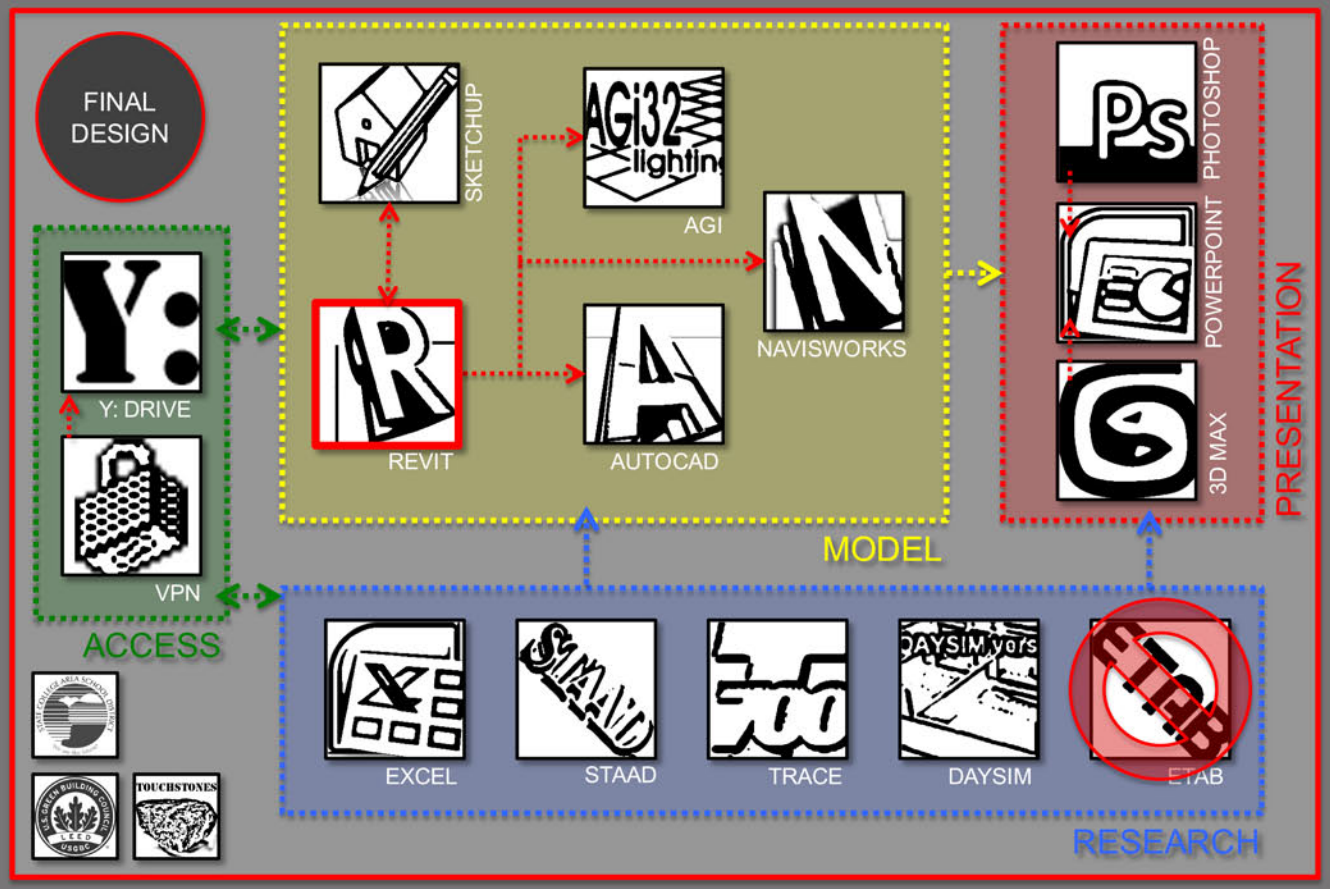
With our current design we have managed to stay under our established budget by a significant margin while providing adequate flexibility of a learning environment. An engaging, aesthetic elementary school that encourages imagination and creativity in the heart of Boalsburg.

All Purpose Room:

Required:	1 @ 5,000 SF
Actual:	1 @ 5,950 SF

Full Service Kitchen:

Required:	1 @ 1,500 SF
Actual:	1 @ 1,560 SF



Final Design

Architecture

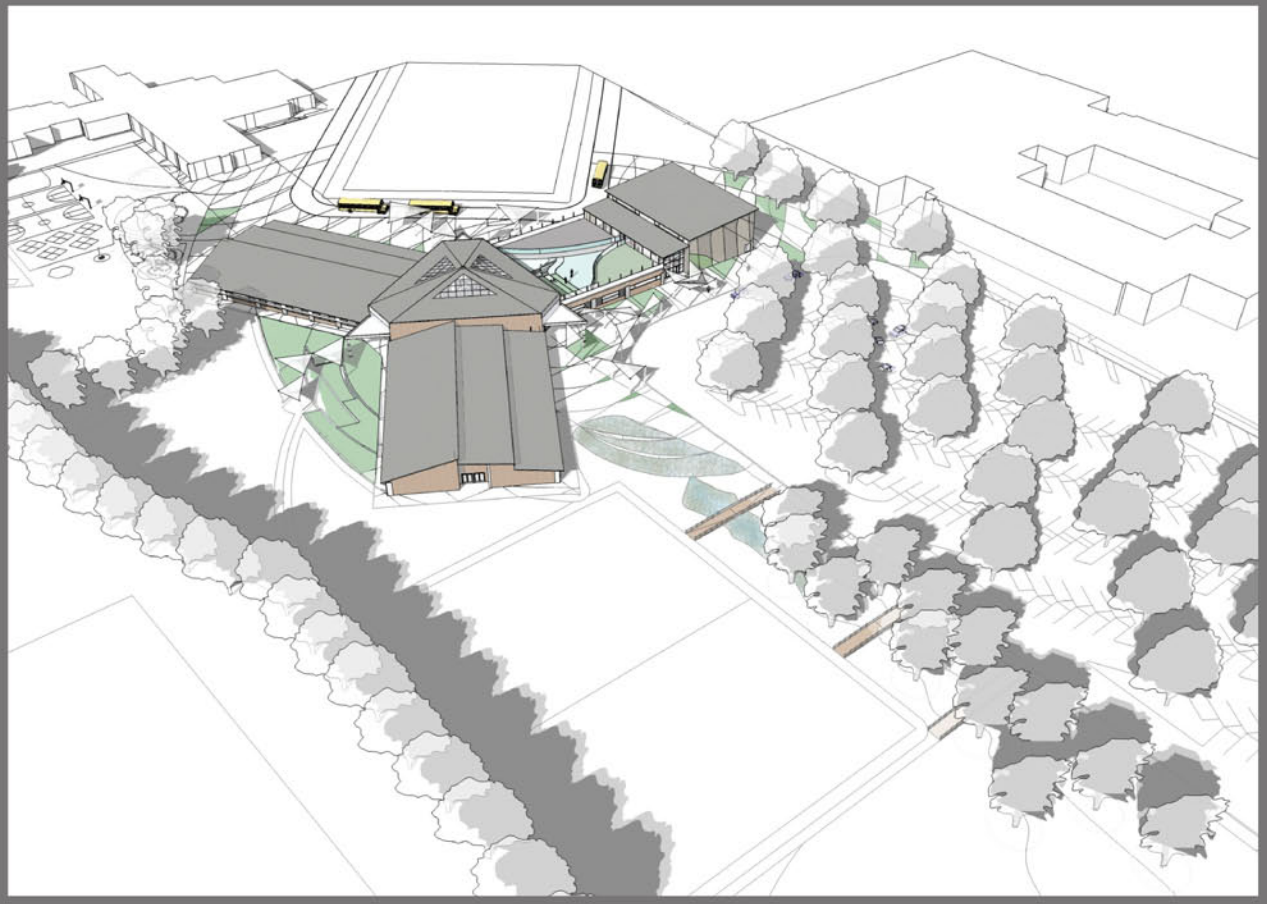
Our final design continued pushing our program spaces even further with furniture, materials, and constructability in mind. Hallways were designed to include cubbies for the students as well as functional aspects such as ceiling access to the mechanical systems. The central tree was further designed as well as the library. The landscape/ hardscape was brought into the building by continuing visual patterns on the floor as well as on the exterior surfaces of the multi-purpose space.

Construction

Estimates of each field of input were completed using various takeoff methods. These figures were compared to the provided existing Mt. Nittany Elementary School figures. A movie was developed to showcase key graphics as well as our 4D model. Systems integration and clash detection became a greater priority as deadlines were approaching. Final site logistics and a final Bim Ex plan was completed for submission.

Landscape Architecture

The final landscape design was generated and renderings began. A masterplan was the most important form of graphic communication as it helped to convey the form generation and traffic patterns found throughout the entire site. Perspective renderings were also completed using our digital model as a base with hand rendering and PhotoShop textures being applied for better graphic communication. Emphasis was placed on the parking lot and other examples of adaptively reused spaces throughout the limits of work.



Lighting / Electrical

The finalization of the electric lighting design was completed for this phase. The result was an electrical lighting system that responded to our established daylight levels throughout the building. DaySim was used for a final daylight study and for photosensor efficiency analysis. This decided the first two rows of electric lights (starting from the exterior window) would be placed on photosensors. Finally, our Revit model was exported into 3D Studio Max for presentation quality photorealistic renderings.

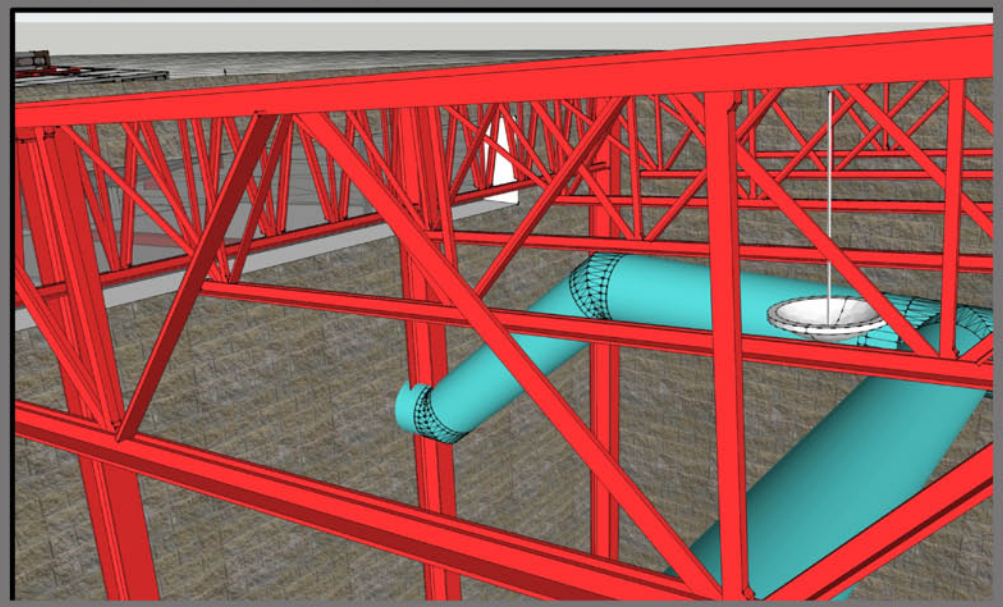
Mechanical

Final design began with the digital modeling of the selected system. The completed MEP model would include: supply and return ducts, heat pumps for every room, an appropriate diffuser layout in each space, sprinkler locations, condensate return, and hot water supply and return for each heat pump. Layout of the mechanical room was organized and equipment and ducts were sized. A final clash detection was run and any errors were corrected.

Structural

The final Revit model was highly detailed and inclusive. Incorporating landscape, structure, MEP, and construction phasing all in one central file. The foundation and structural steel systems were finalized based on iterations throughout the design process. All necessary calculations were completed and member sizes were determined. Structural analysis programs were run to verify all results. Finally, graphic renderings were produced to demonstrate the integration of all building systems and final clash detections were run.

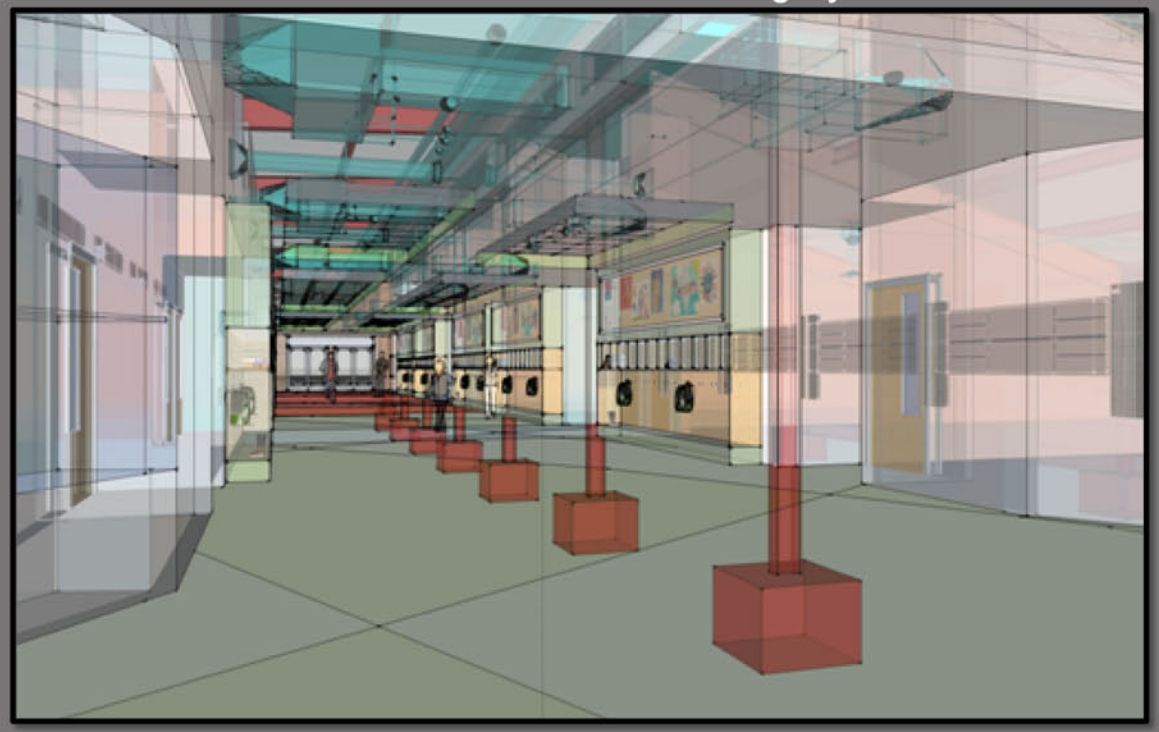
Clash Detection Screen Shot



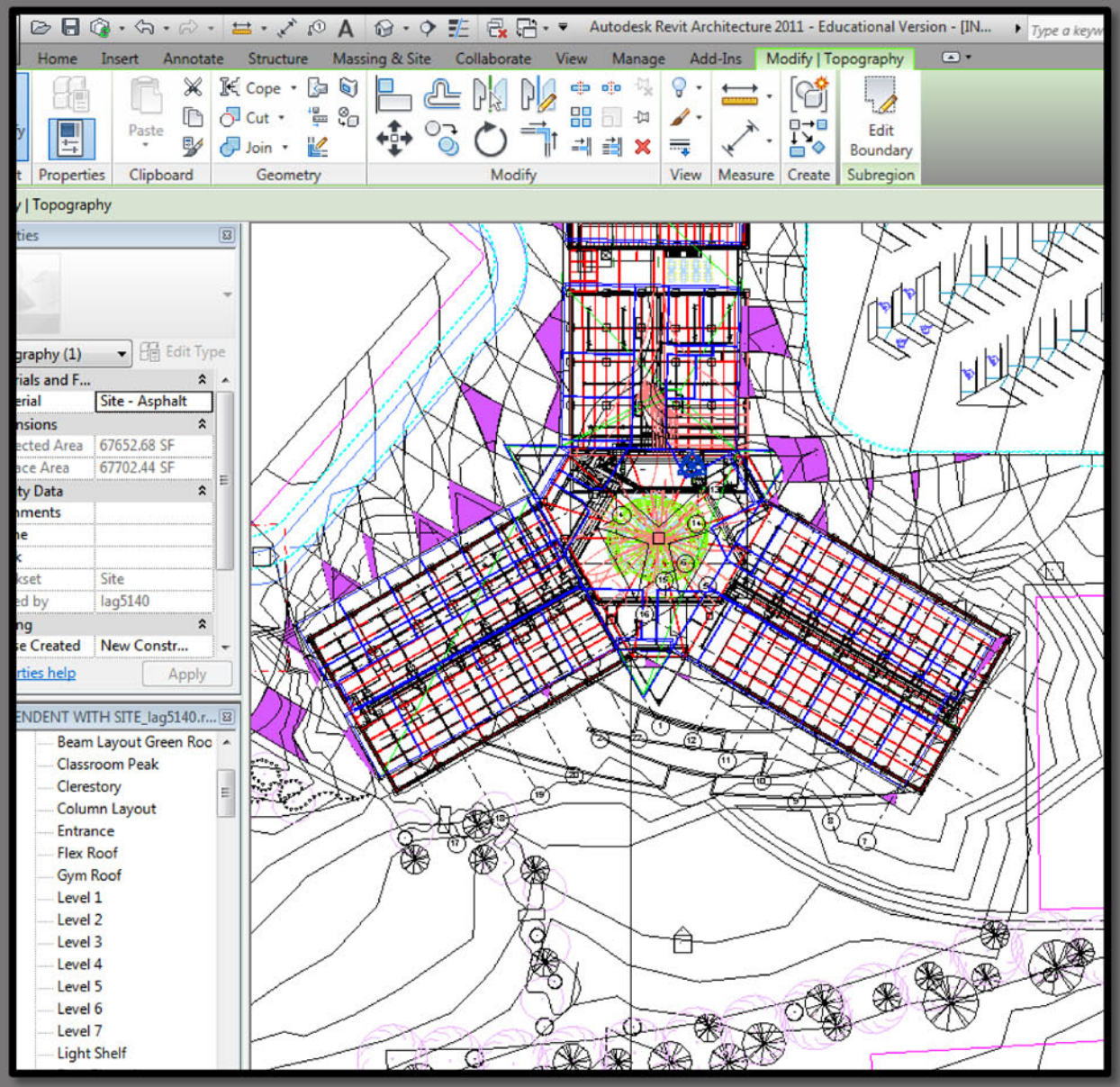
Digital Model

The importance of the digital model cannot be over-stated. As BIM requires a collaborative digital model for success, a cohesive central file is vital. Visual clash detections can be conducted as the building is developed before formal clash detections must be used. This saves time and energy on the part of every designer.

Interacting Systems Screen Shot



Central File Screen Shot

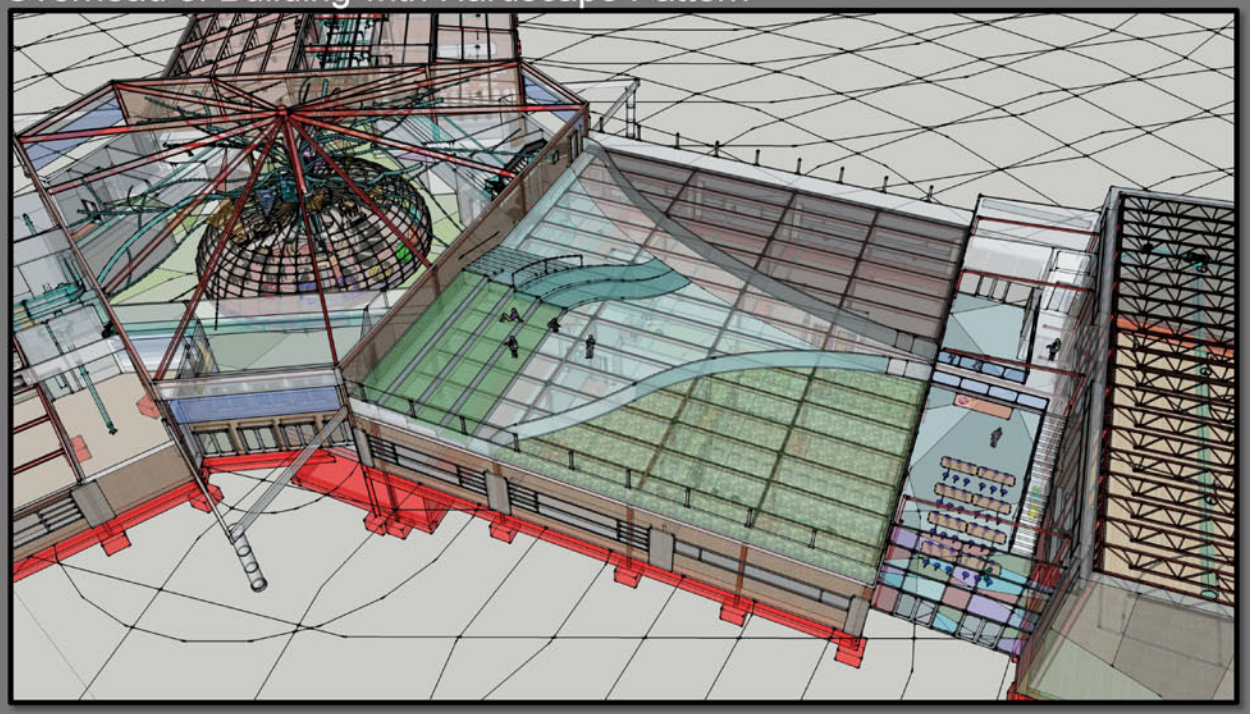


left: An example of visual clash detection during building development

bottom left: An x-ray rendering displays just how complicated multiple systems can become

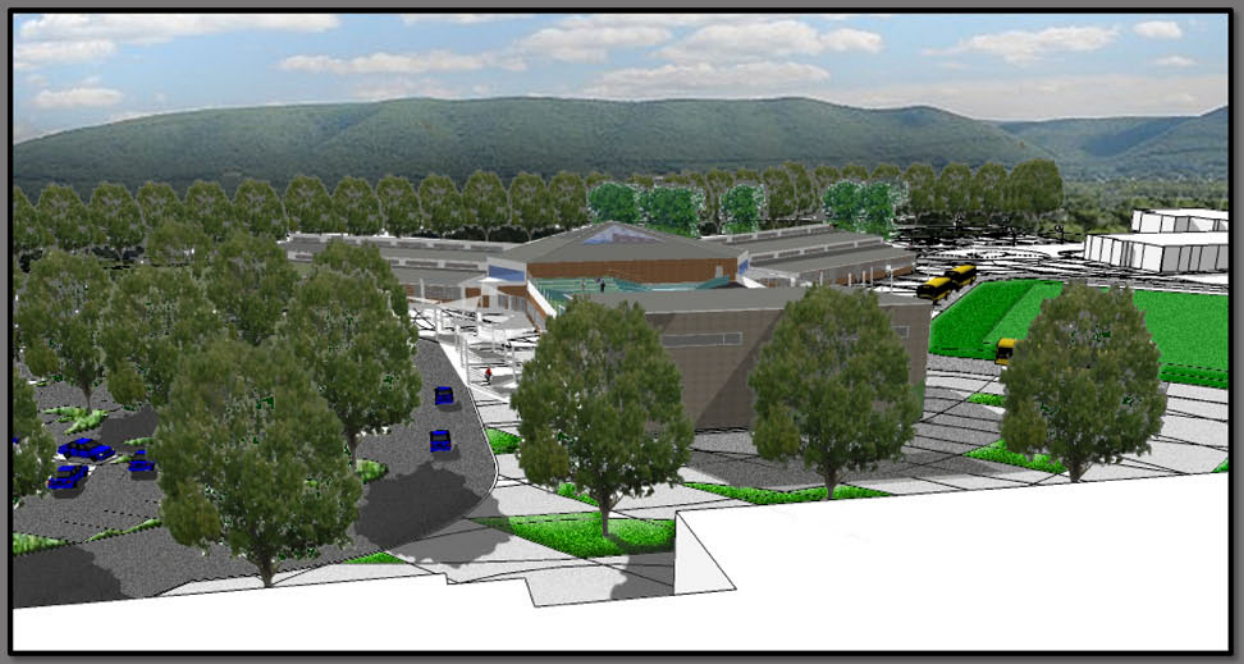
right: A screen capture of our final central file which incorporated every discipline's work

Overhead of Building with Hardscape Pattern



Greenroof X-Ray

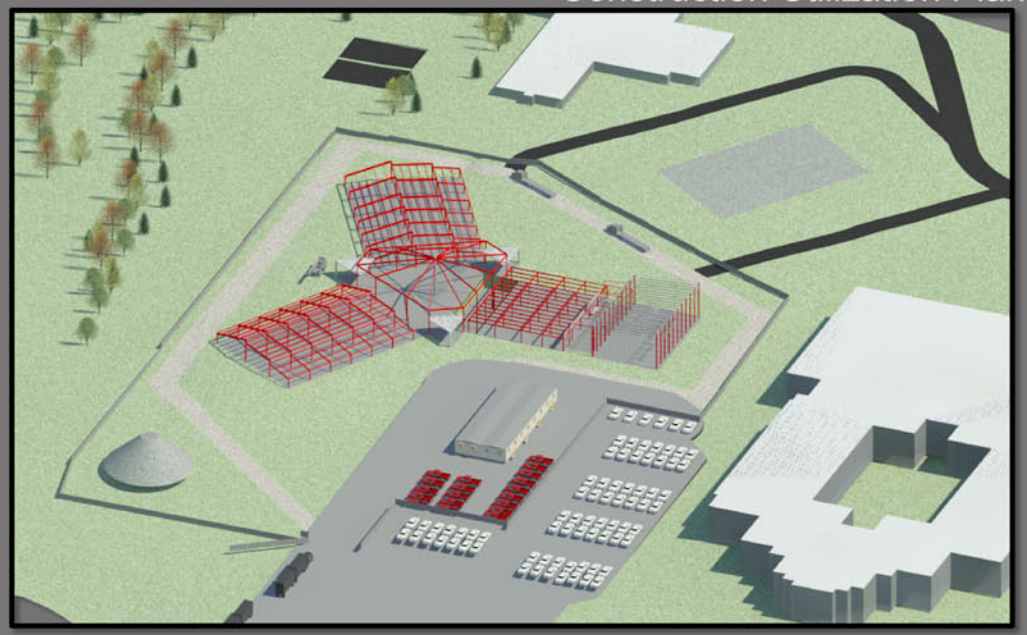
This overhead rendering shows the greenroof located above the service areas such as the kitchen and storage facilities.



Entry Perspective X-Ray

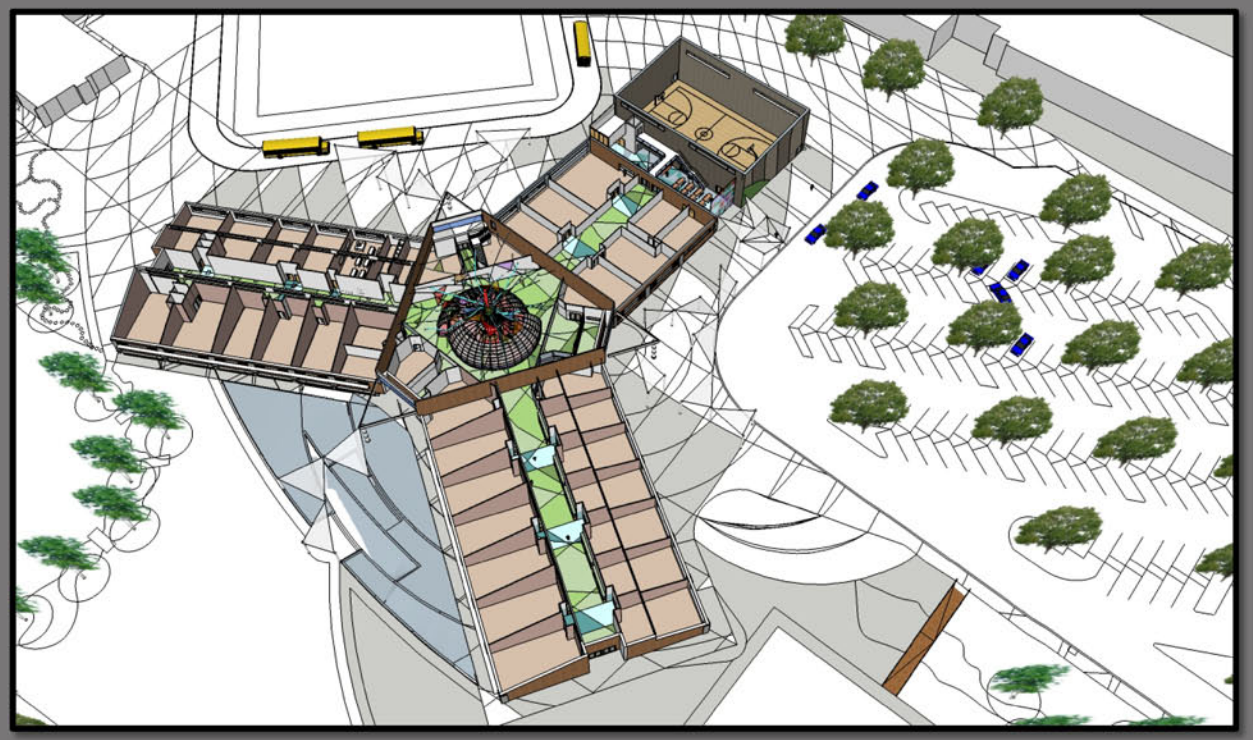
From the roof of the existing middle school you can see how quickly the continued canopy through the parking lot and playground help to blend the building into the existing landscape.

Construction Utilization Plan



Site Utilization

Every construction site needs a spoils pile.

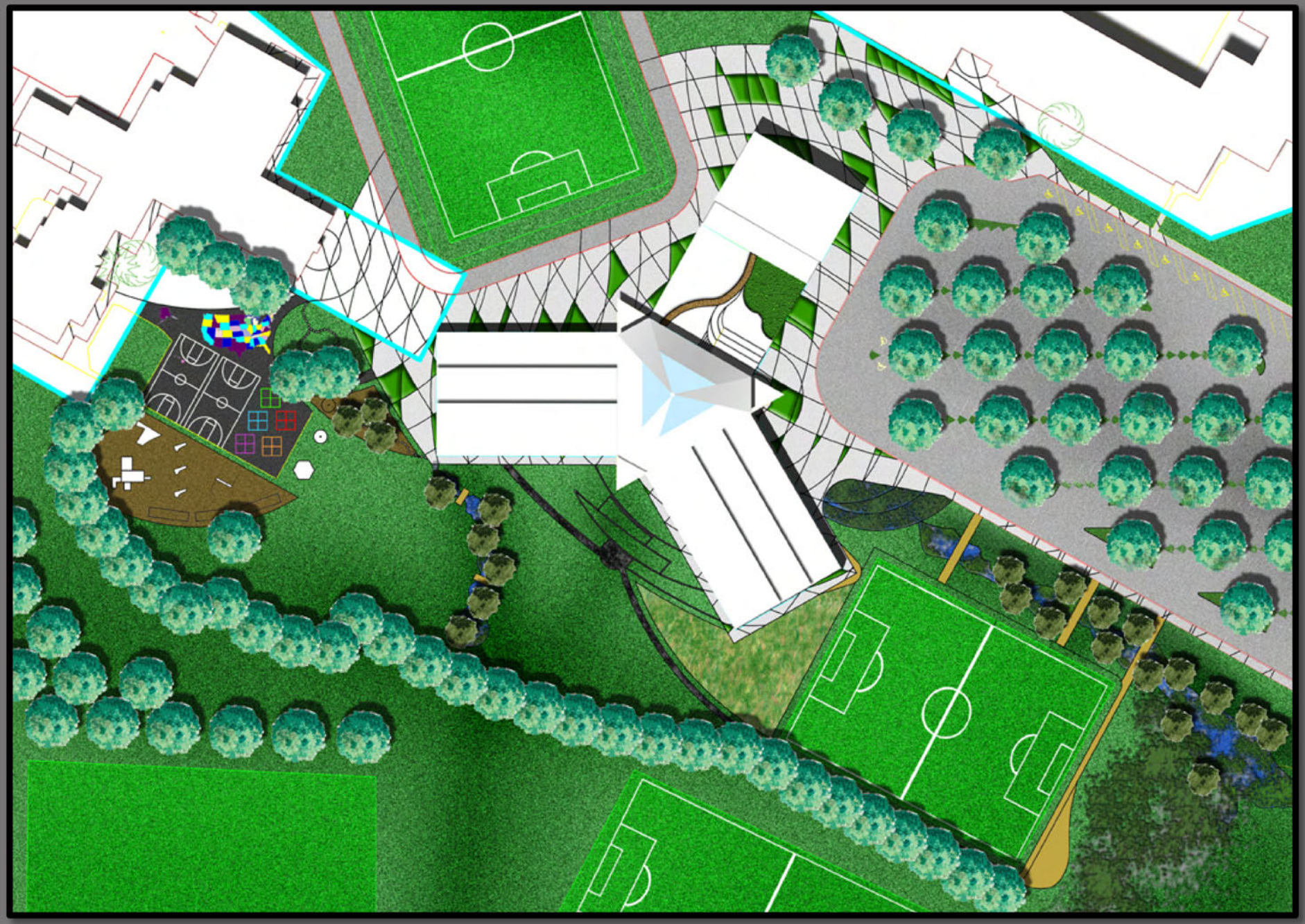


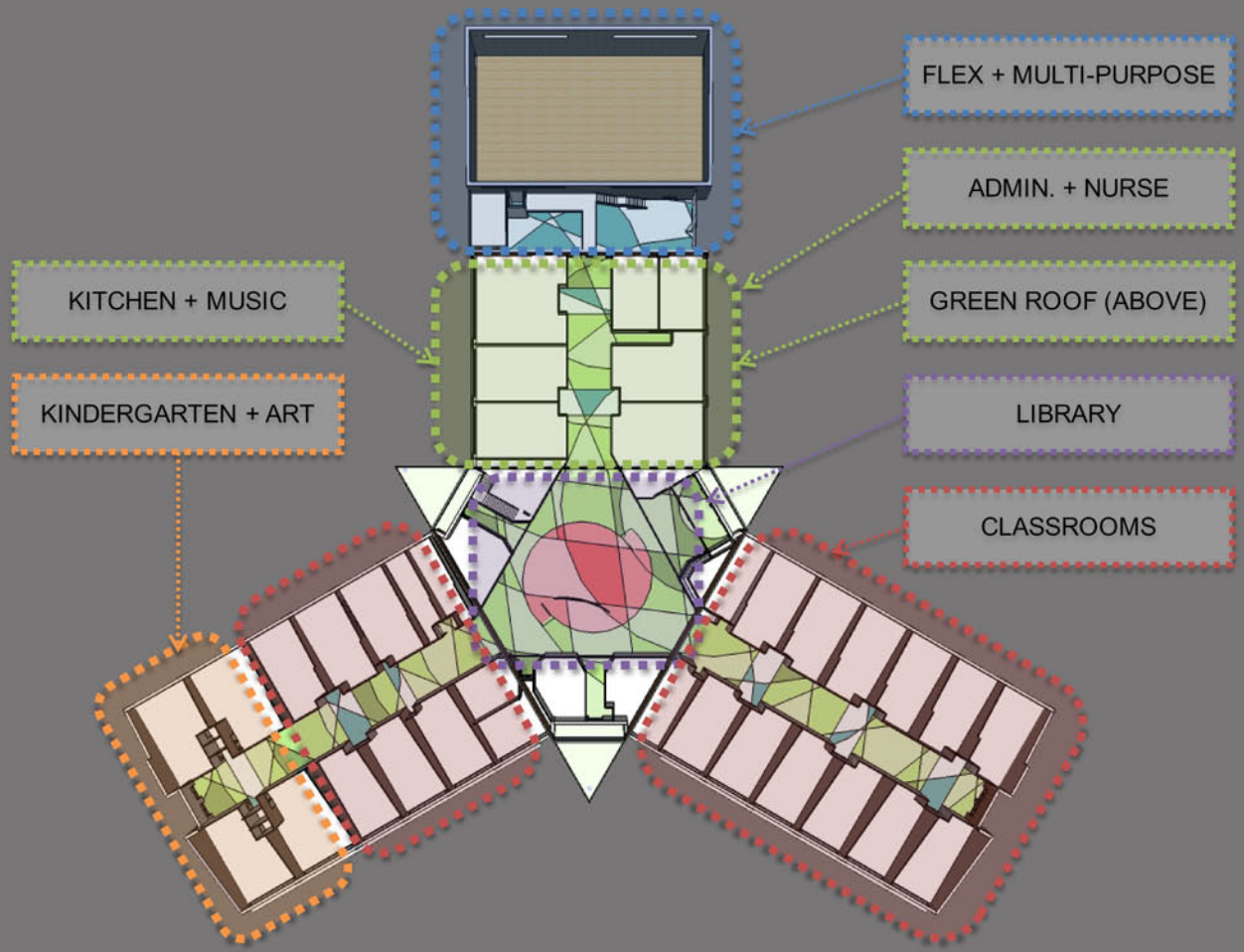
Realigned Parking

This bird's eye rendering provides a good look at the realigned parking stalls and entry roads.

Master Plan

Separating traffic patterns to ensure children's safety was a priority of this site design. The existing access road to the north was maintained and adapted northwest of the proposed school to create a new bus service loop. Parents and faculty will continue to use the parking lot as a drop point in front of the main entry. This will prevent any interaction between small cars and buses while they are both on site. The existing soccer field will be relocated to the northwest of the building where it will be encompassed by the new bus service road. The existing soccer field to the southeast of the building will be maintained, but encroached upon by the building footprint. This will create a mini-field for small community pick-up games or practices. All other existing recreation fields on site will be preserved. The parking lot has been realigned as another measure of safety. It will become a series of one way travel lanes with angled parking. The existing playground has been expanded to accomodate the increasing student population. A stormwater garden has also been added to the east of the playground to provide another engaging element for outdoor recreation. Lined by River Birch trees with small bridges, this has the potential to quickly become a favorite amongst children interested in insect and amphibian life.





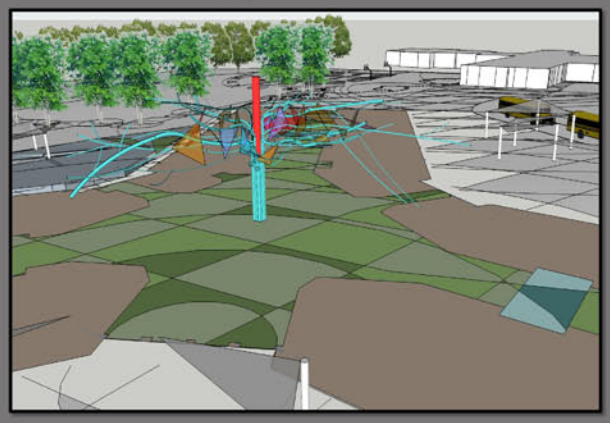
Floor Plan Organization

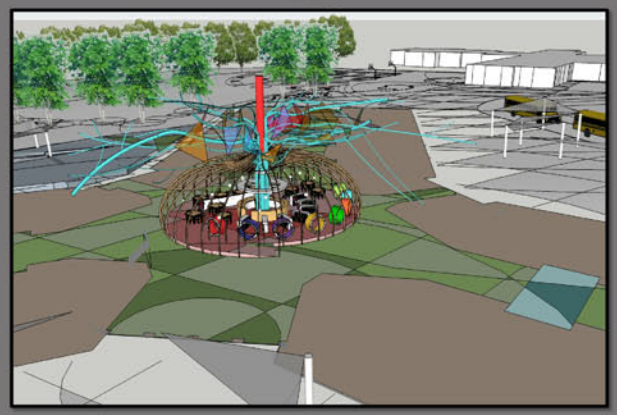
Keeping the classrooms near each other helps to minmize required infrastructure needed to service each room. The multi-purpose space at the northern end of the building separates the more noisy activities such as gym and lunch from the other classrooms.

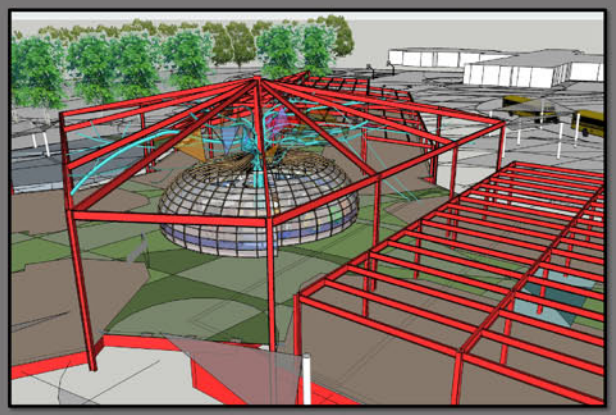
The hardscape pattern has been brought into the floor plane of the interior of the building to add coordination between site and building.

The south-facing classrooms have a viewshed of the Tussey Ridgeline while the northeastern classrooms view Mount Nittany. The northwestern classrooms have a view across the soccer field to the Bald Eagle Ridgeline. Careful orientation has given each classroom an engaging view to a natural environment from the windows.

below: This sequence shows the compilation of each system starting with the central library, adding the structure, MEP, walls, and finally the roof







right: the program requirements were rather explicit with the expected rooms and uses. Here we see the allocated space for each

Program Correlation

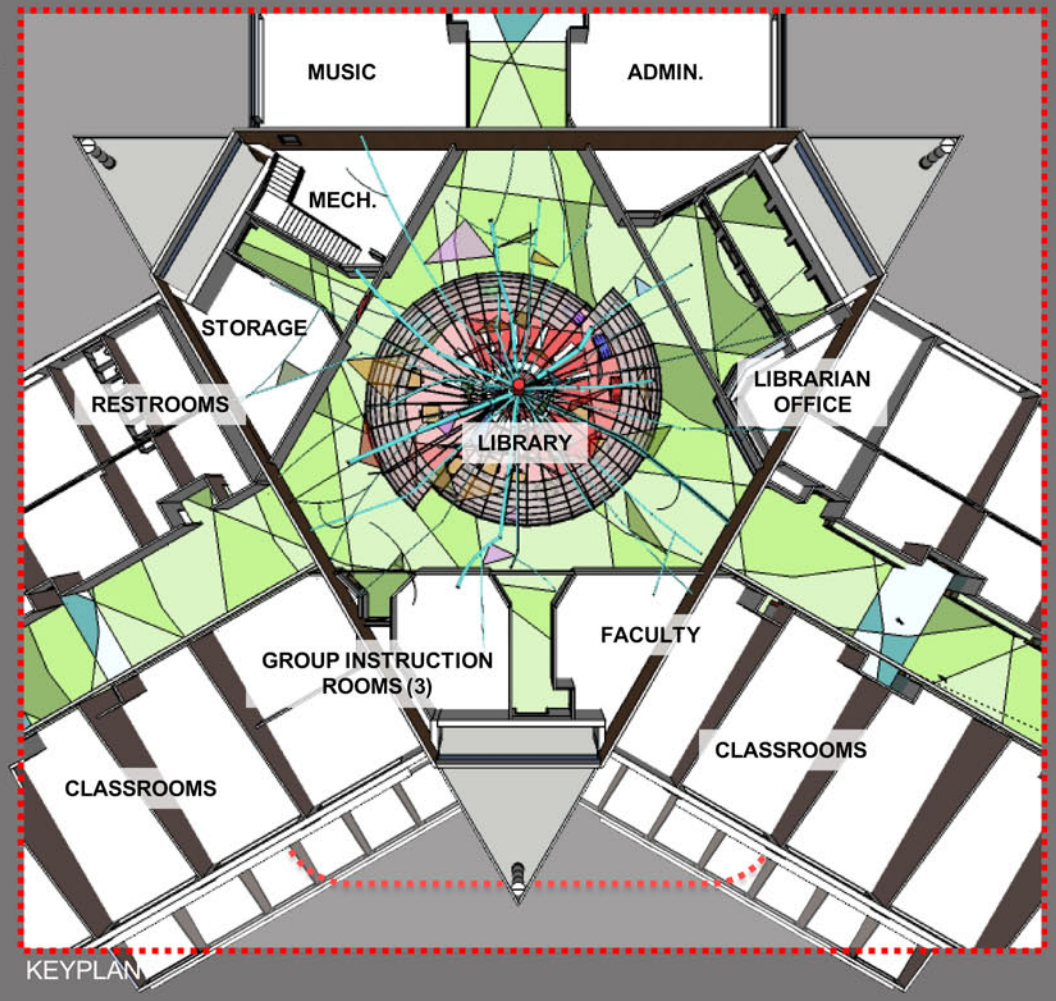
Library -
Required: 1 @ 2,000 SF
Actual: 1 @ 2,066 SF

Librarian Office -
Required: 1 @ N/A
Actual: 1 @ 756 SF

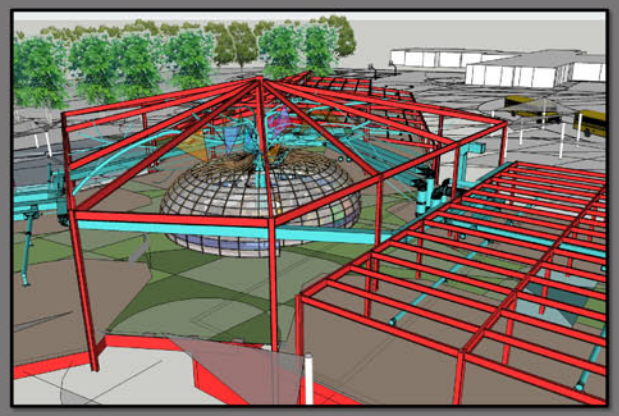
Administrative Offices -
Required: 1 @ 1,500 SF
Actual: 1 @ 1,500 SF

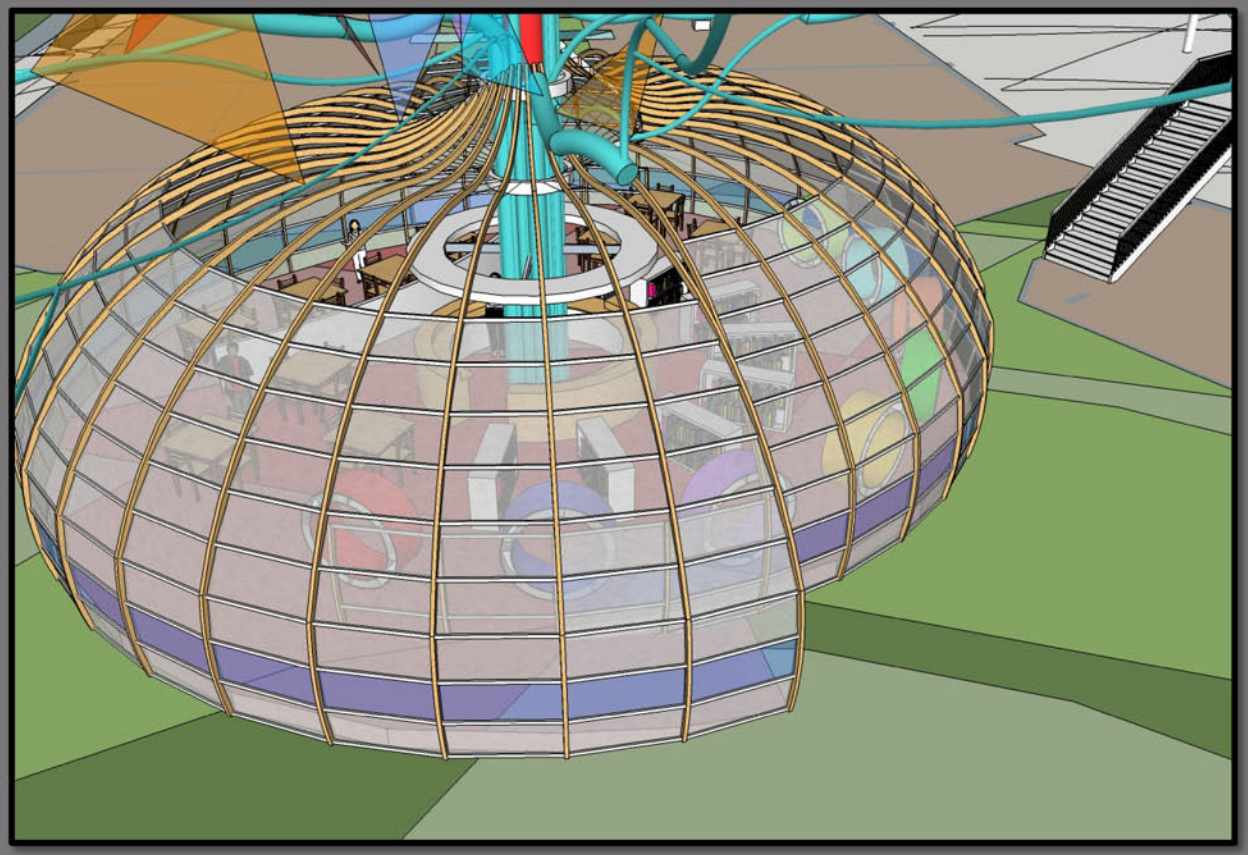
Nurse's Suite -
Required: 1 @ 900 SF
Actual: 1 @ 1,048 SF

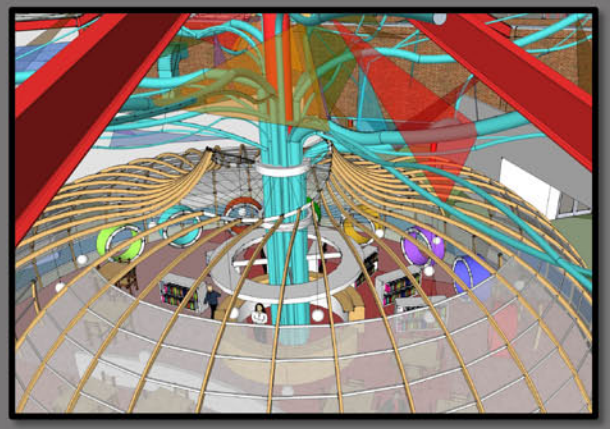
Faculty Lunch/Work -
Required: 1 @ 800 SF
Actual: 1 @ 1,150 SF

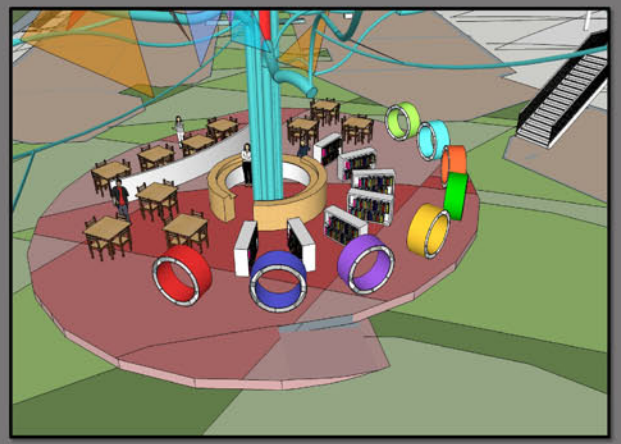


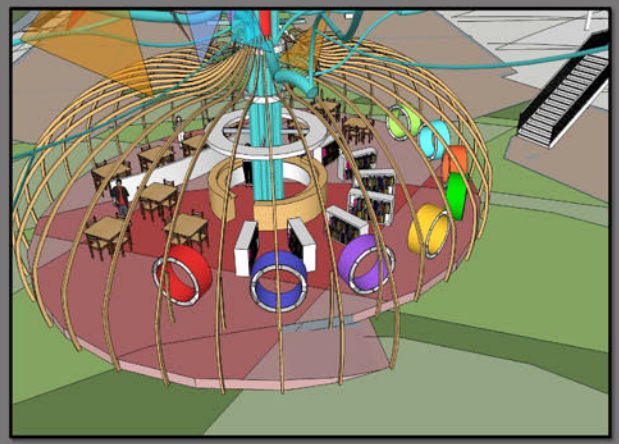
KEYPLAN





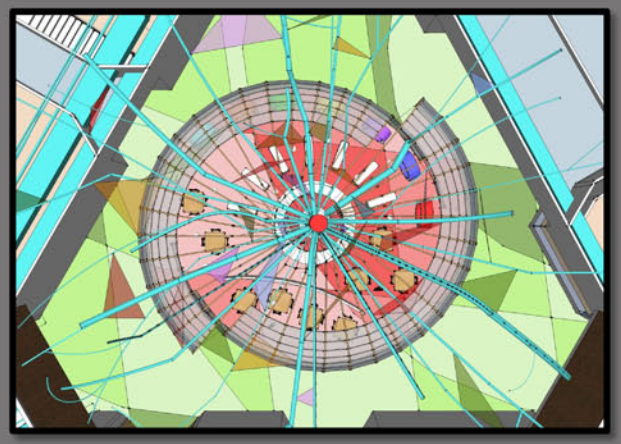


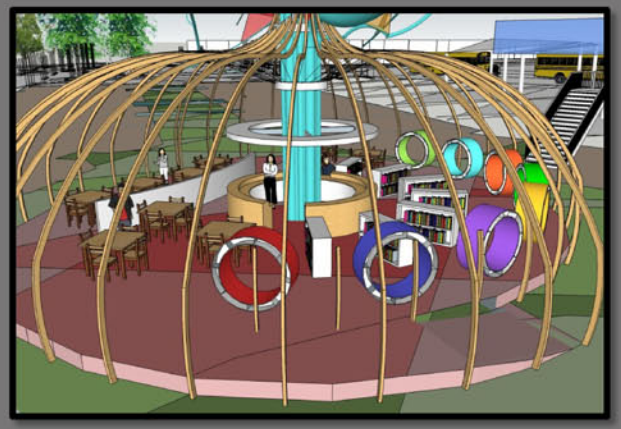


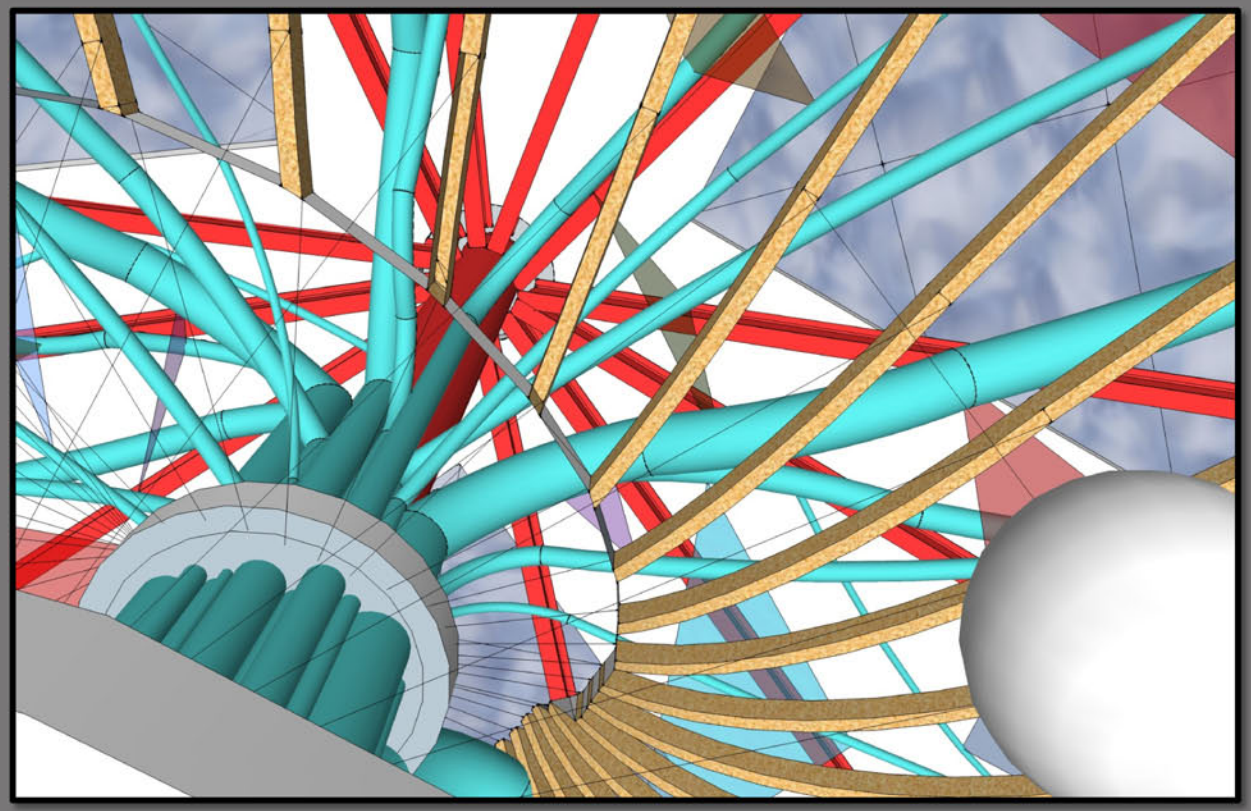


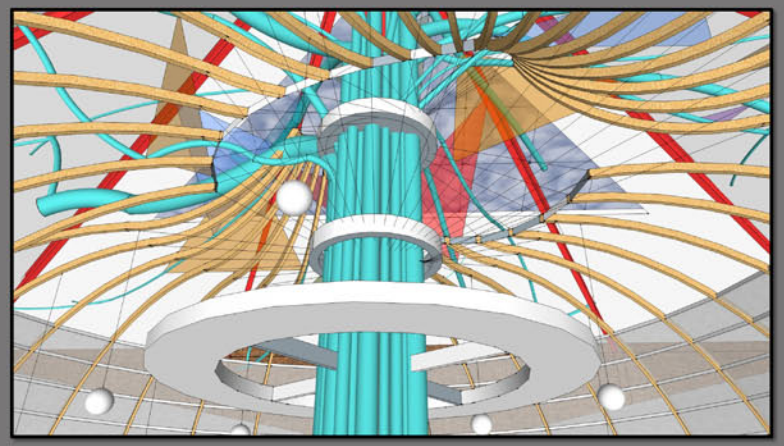
Library Acoustics

The outer panels of the library are soft enough to absorb a good deal of noise generated within the library. The open ceiling allows some sound to escape while the walls surrounding the exterior of the space will be clad with acoustic panels to ensure sound dampening. Terminating the curve of the walls before apex helps to project sound up instead of around as well.







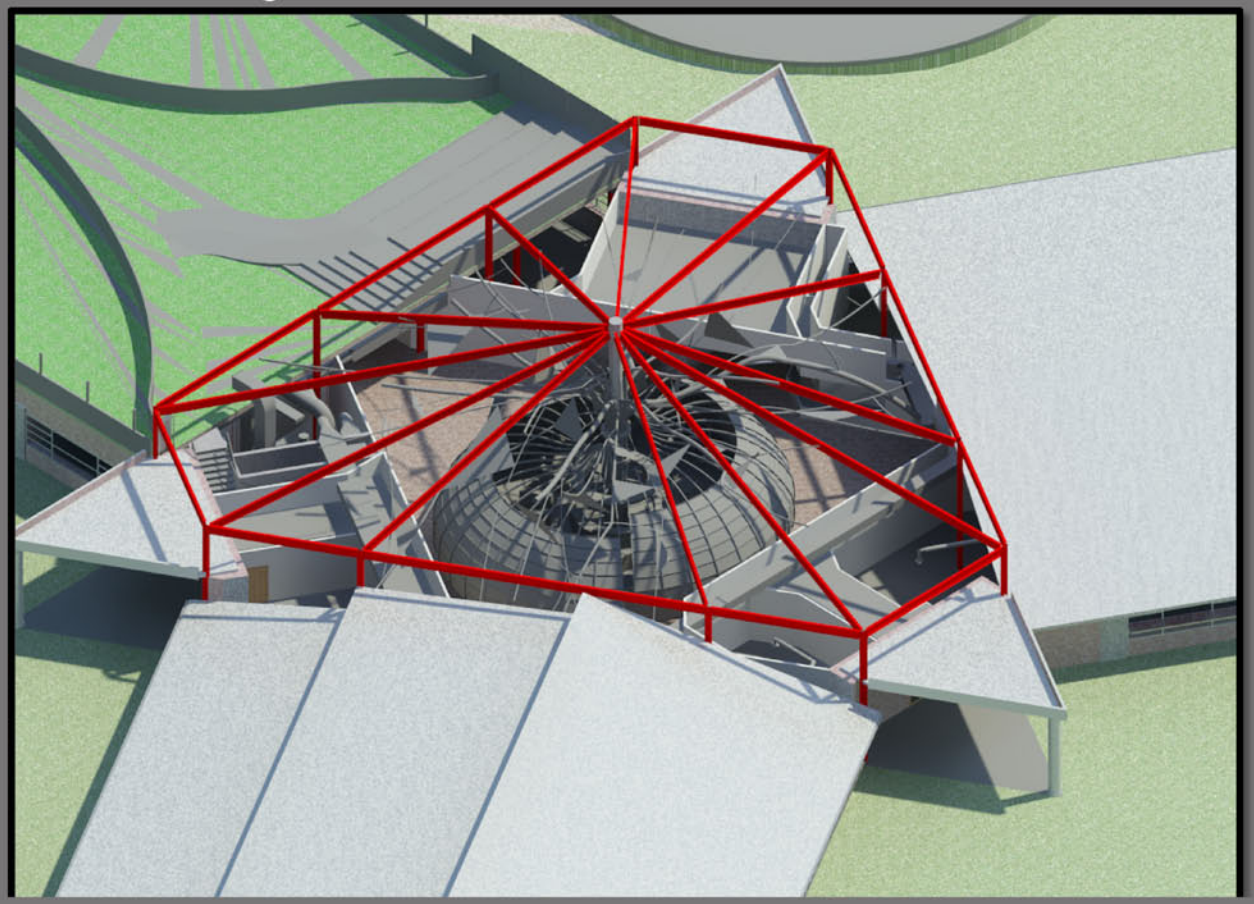


top right: Looking through the ceiling of the library one can imagine the dappled light penetrating to the floor

top left: A plan view of the library shows the branching pattern of the central "tree"

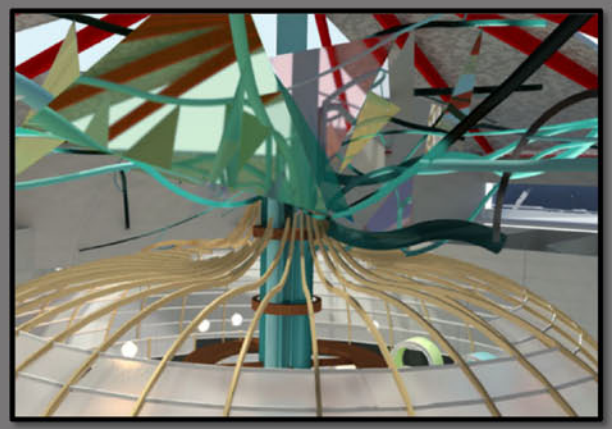
right: A child's perspective of the librarian's desk and stacks

Aerial Rendering



Lighting a Treehouse

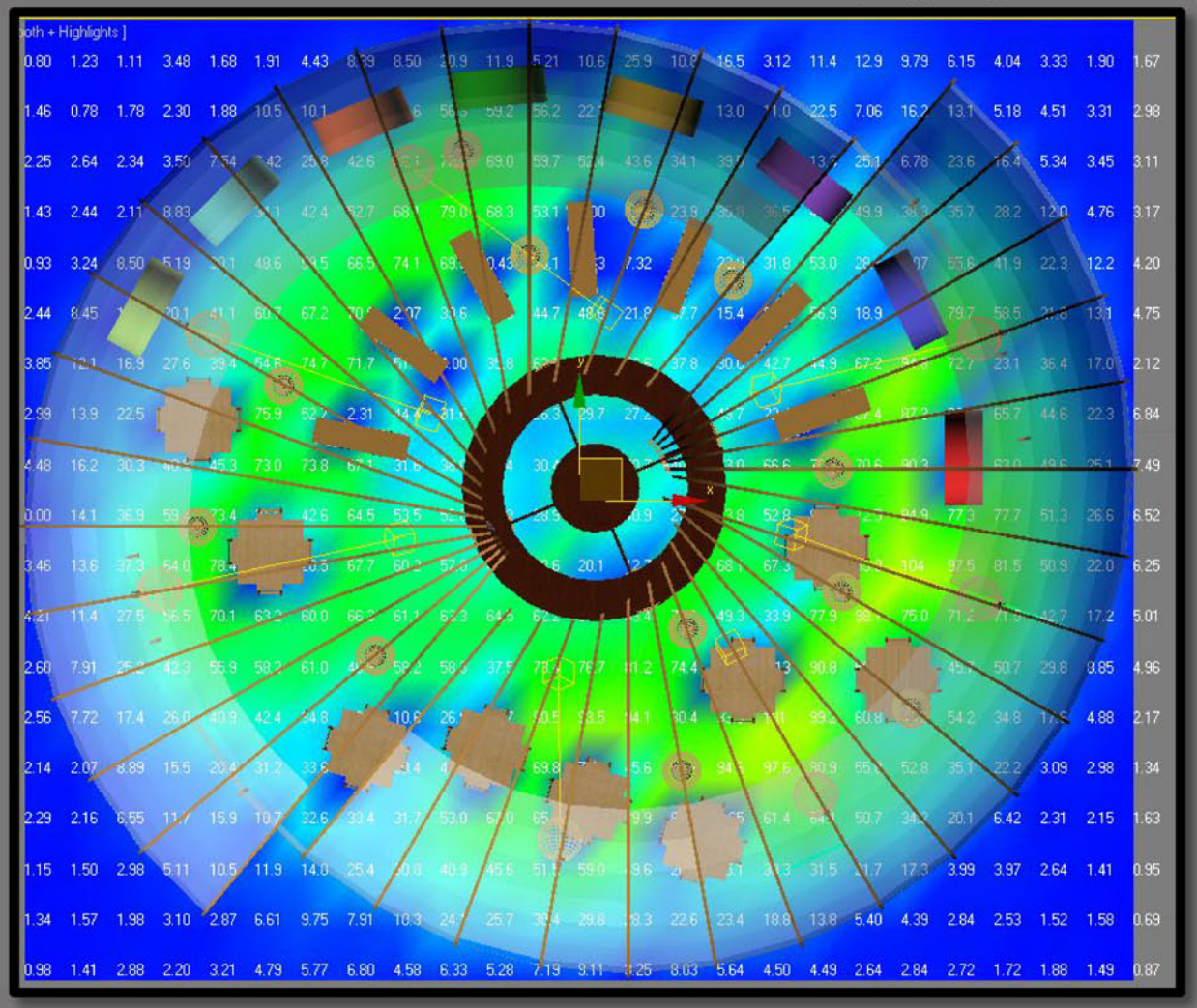
As dappled light isn't ideal to read by, subsidary auxiliary electric light must be added to compensate. These globes are unobstructive and aesthetically pleasing. The can lights under the soffit above the librarians desk are hardly noticable except for on the desk surface they project onto.

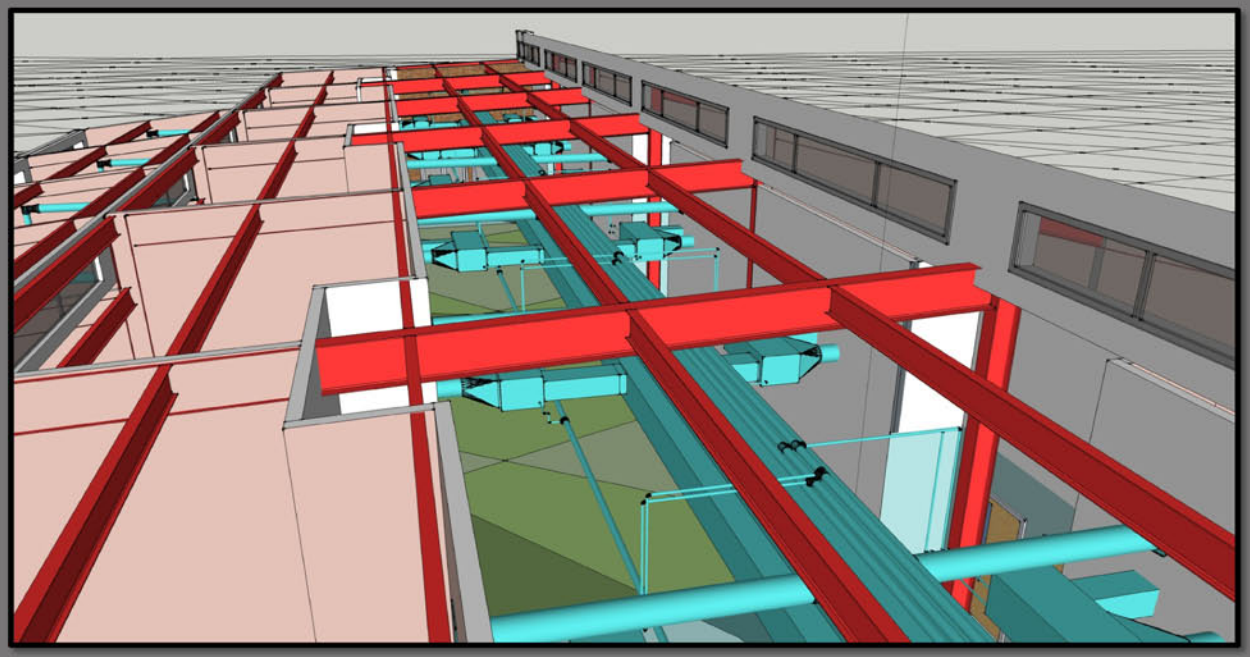


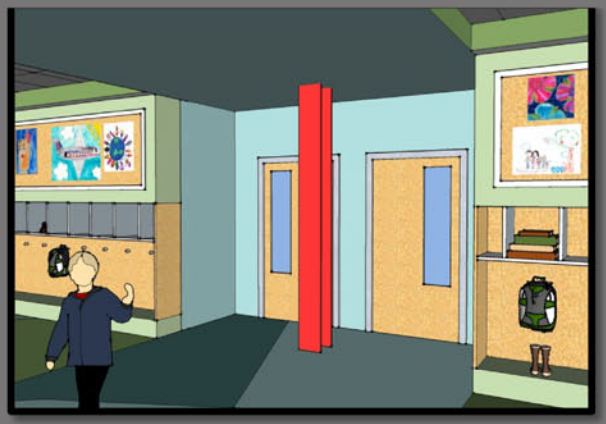
Library Lighting Level Study

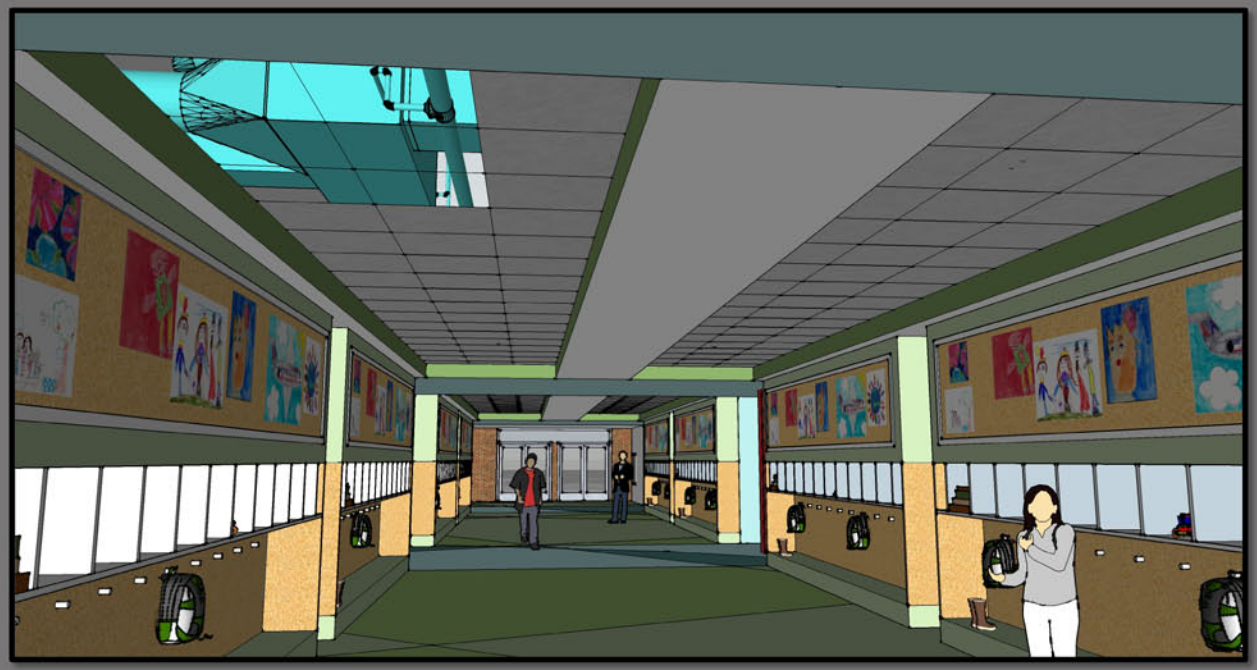
Uniform Distribution

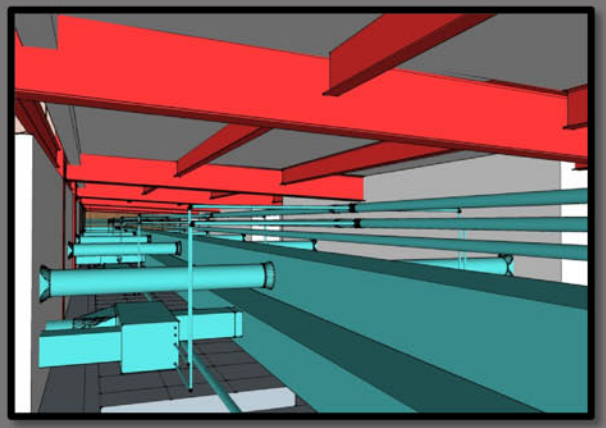
Equal distribution of light is important for an environment designed for reading. Codes require nearly 50 foot candles for an atmostphere conducive to reading. Thankfully our skylights provide the majority of this light and the darker pockets are taken care of by dedicated electrical light fixtures.

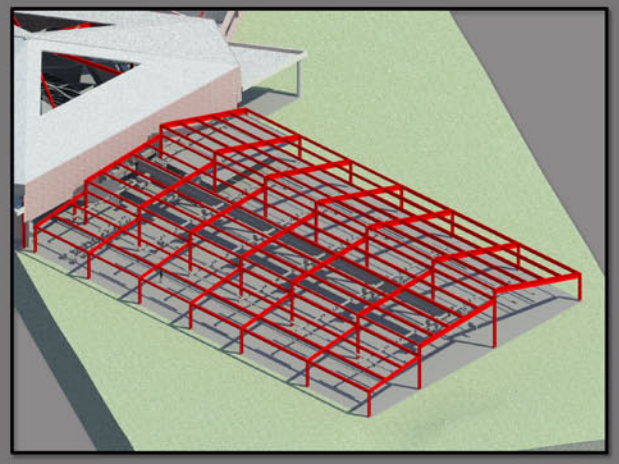


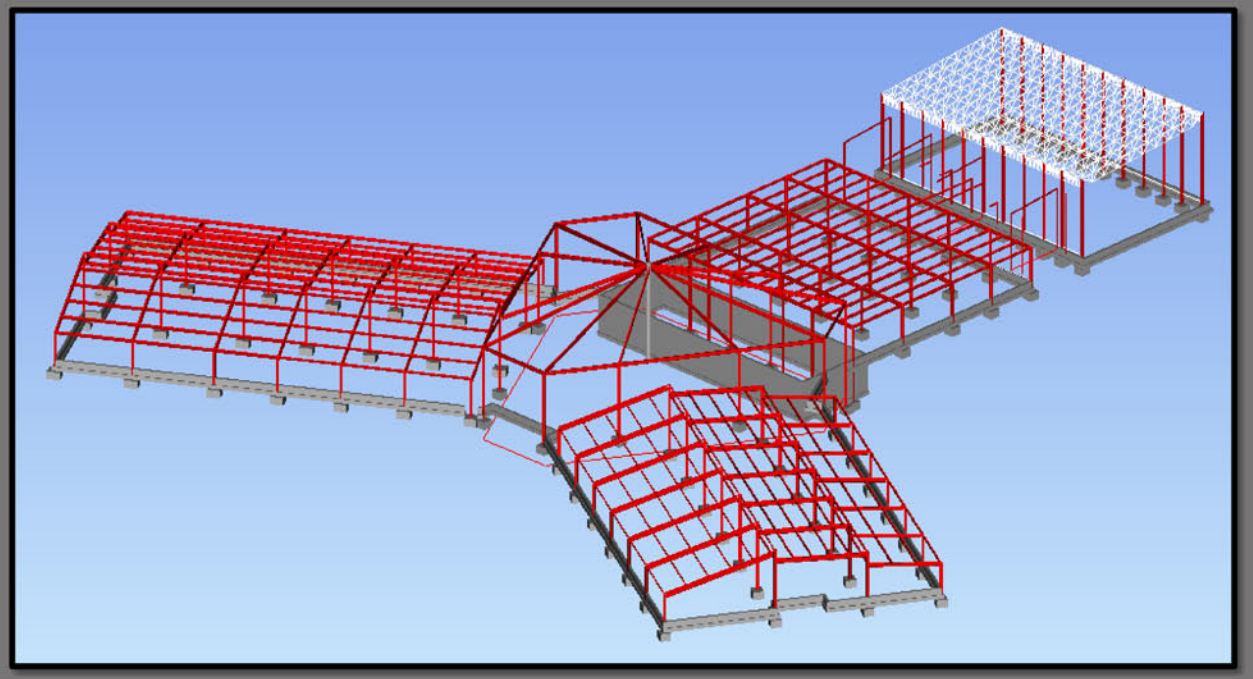






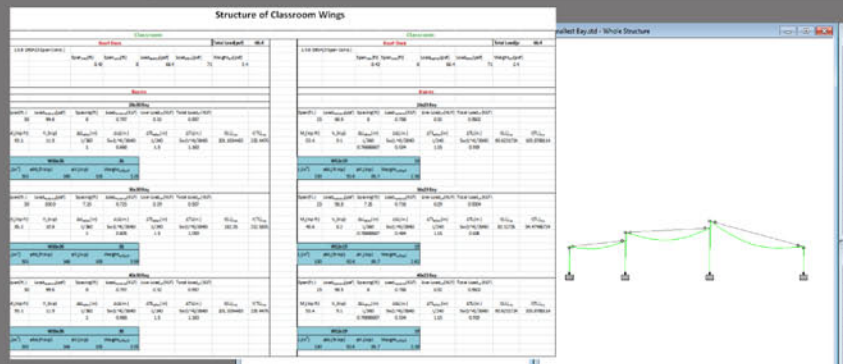


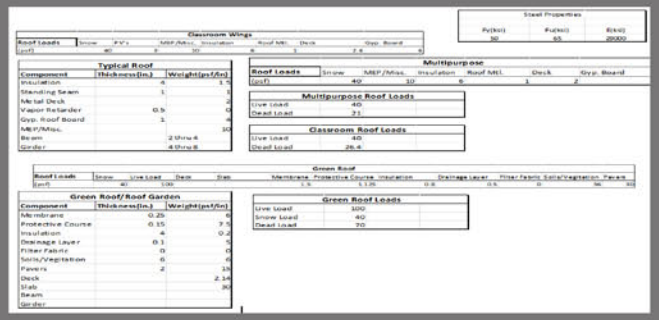


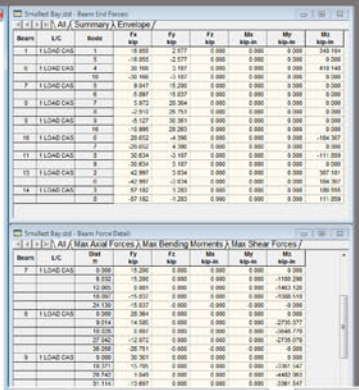


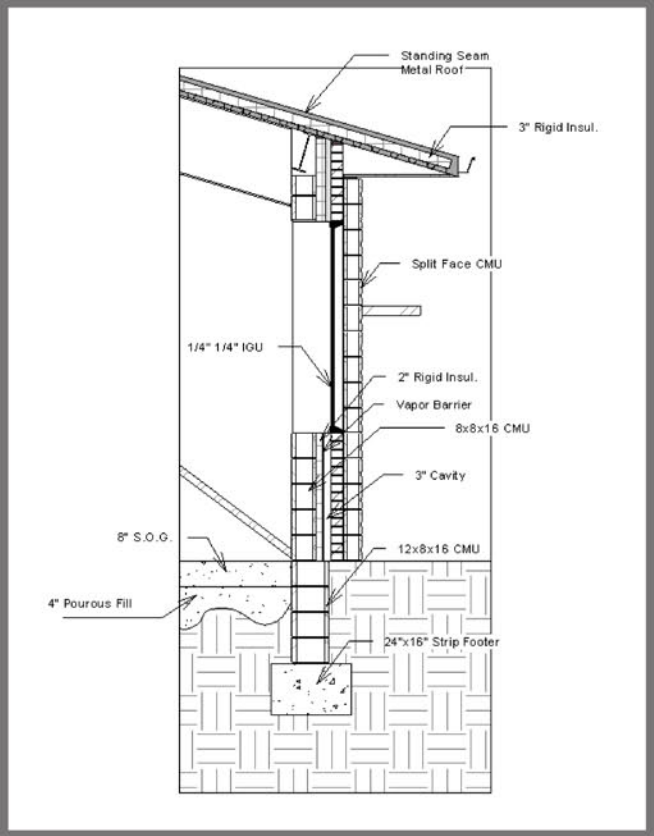
Structural Organization

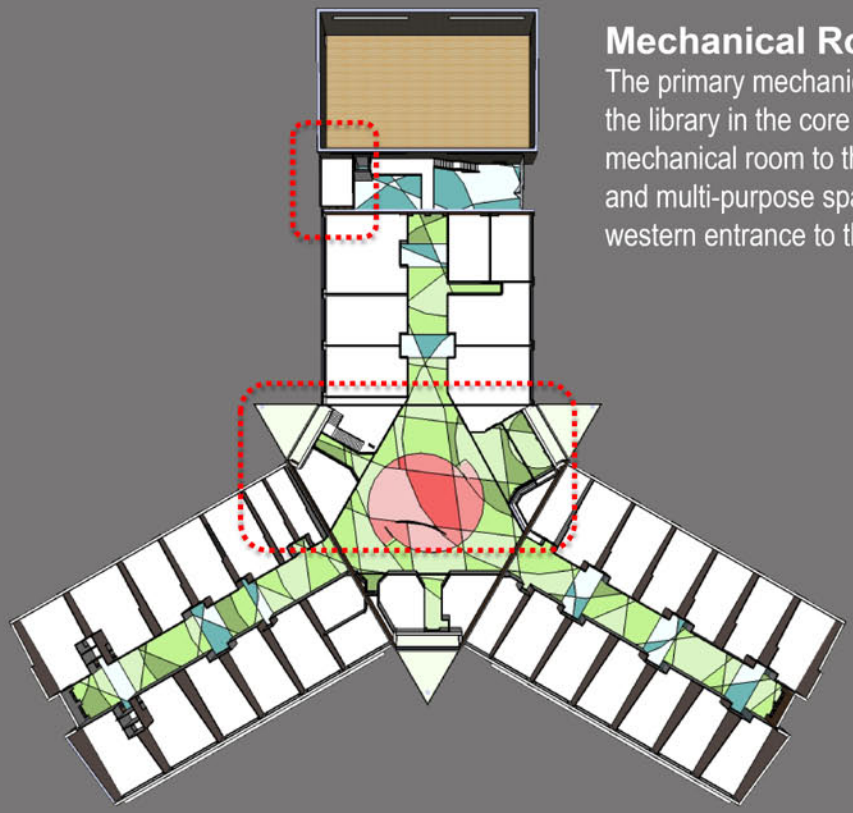
Digital testing of proposed structure is necessary to ensure overall project stability.









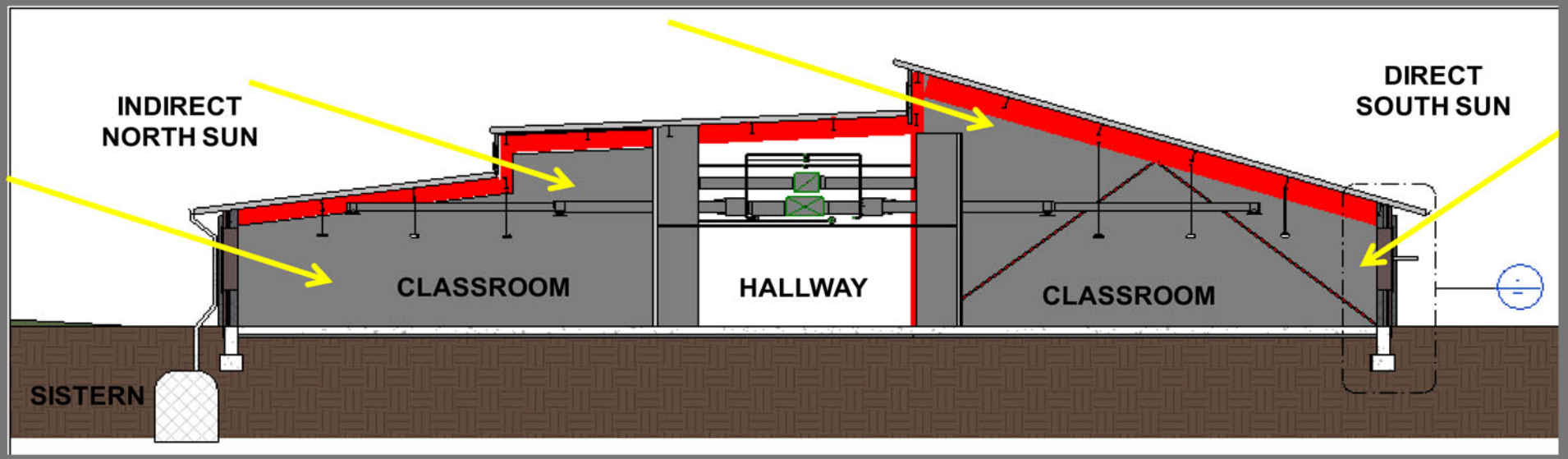


Mechanical Rooms

The primary mechanical room is located beneath the library in the core of the building. The mechanical room to the north serves only the flex and multi-purpose space and is lofted above the western entrance to the flex space.

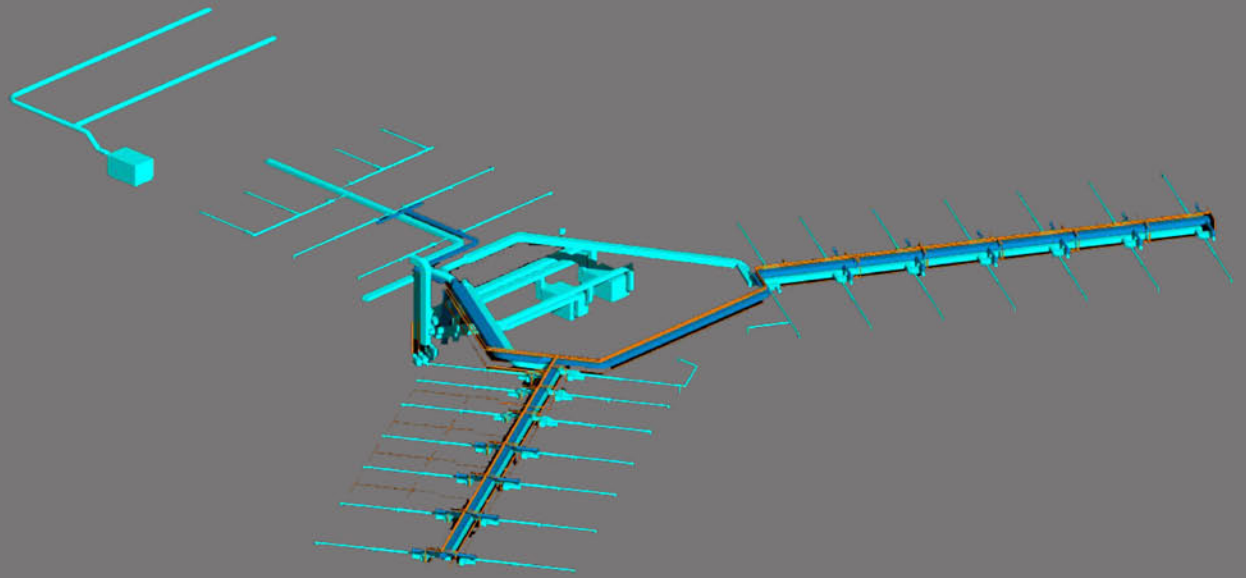
left: This detail shows building enveloping complete with flashing and soffit

bottom: A full building envelope shows how each discipline is integrated into the final design



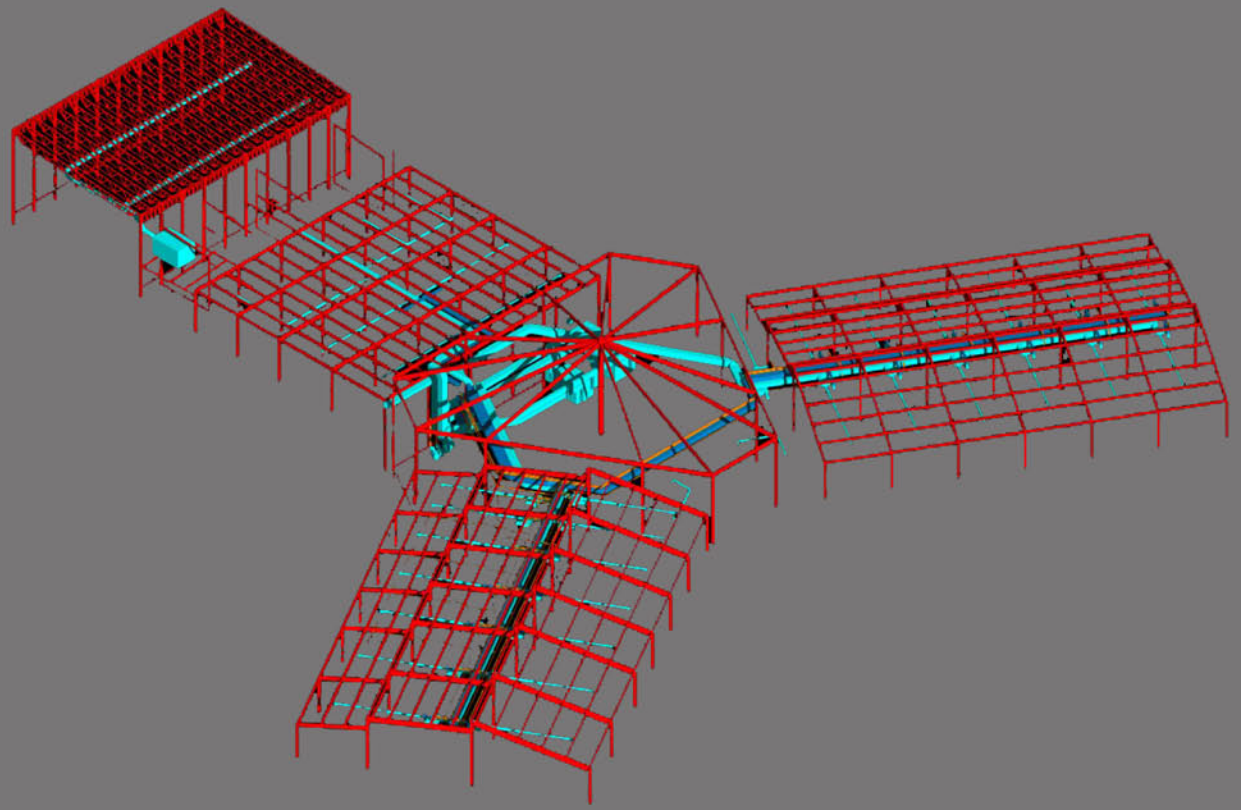
Mechanical Fact Sheet

- **Dedicated Outdoor Air**
  - 2 9000 CFM ERV's
  - 1 6500 CFM ERV
- **Ground Coupled Heat Pumps**
  - 1 3 ton heat pump per class room
  - 75 wells @ 300ft (320 max depth in State College)



Systems Integration

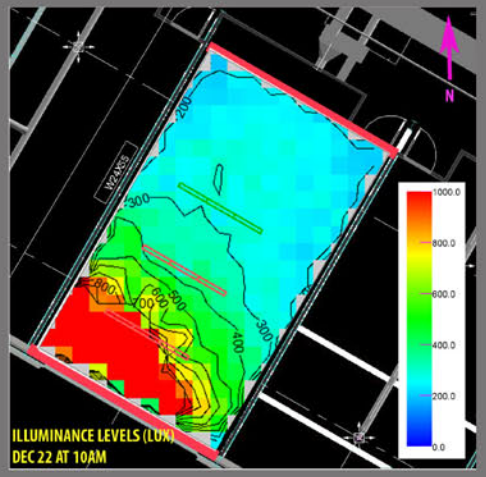
Structural and MEP systems are digitally modeled to run visual clash detection as further modeling is developed around the systems.

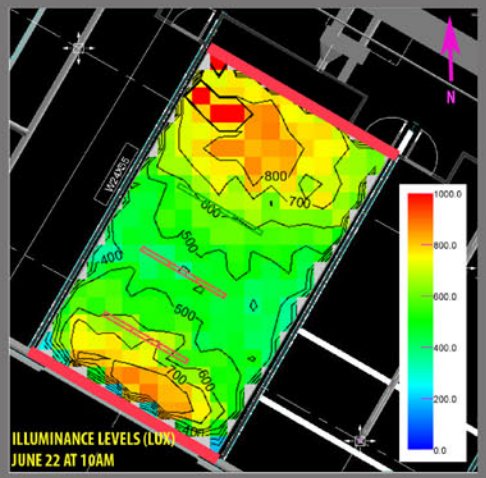


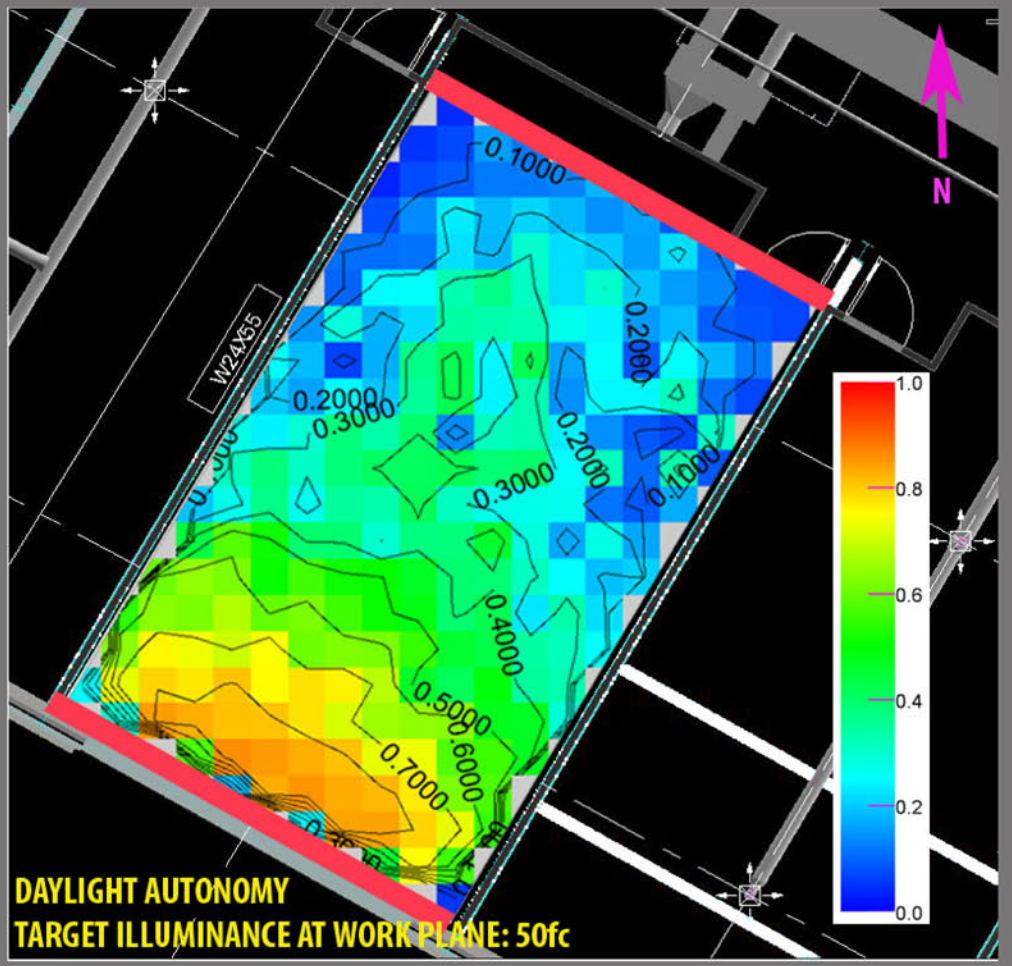
right: A reflected ceiling plan shows sprinklers, ventilation, lighting and structural systems

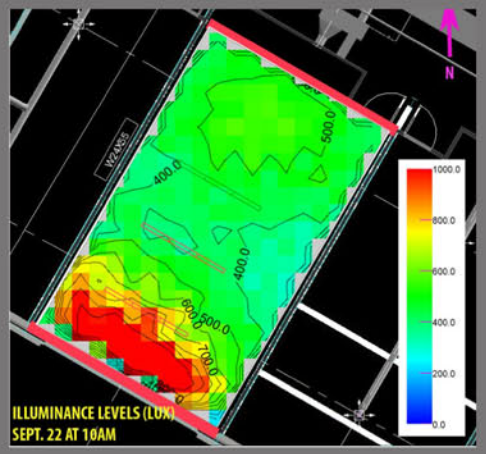
Cross-Bracing

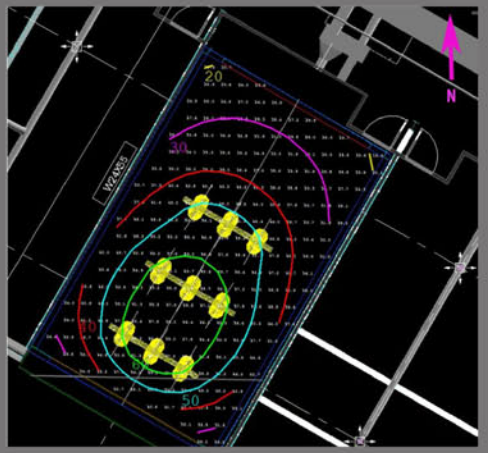
The bracing encroaches slightly into the classroom to add to the teaching tool of exposed structure. Exposed beams, columns and MEP systems also lend themselves to an educational opportunity. An early clash detection discovered that with classroom orientation a few of the cross-braces had to be relocated do to collision with boards in the front of the classroom.

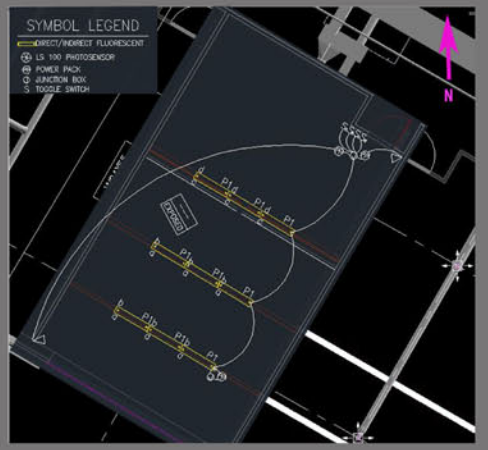

ILLUMINANCE LEVELS (LUX)
DEC 22 AT 10AM


ILLUMINANCE LEVELS (LUX)
JUNE 22 AT 10AM

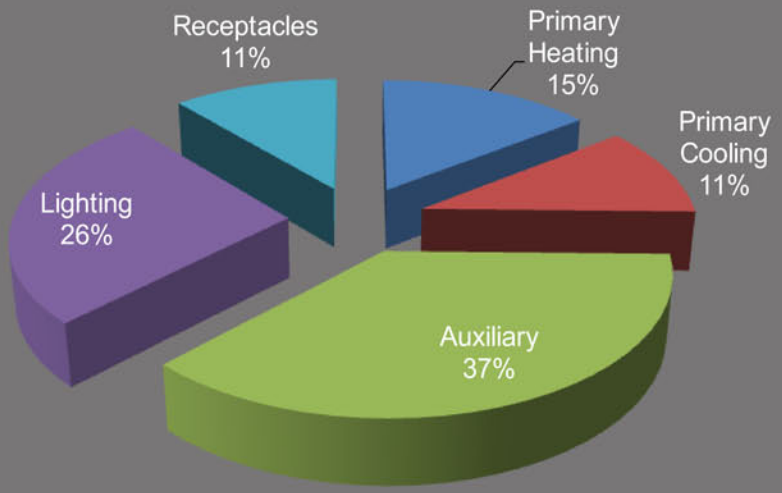

DAYLIGHT AUTONOMY
TARGET ILLUMINANCE AT WORK PLANE: 50fc


ILLUMINANCE LEVELS (LUX)
SEPT. 22 AT 10AM

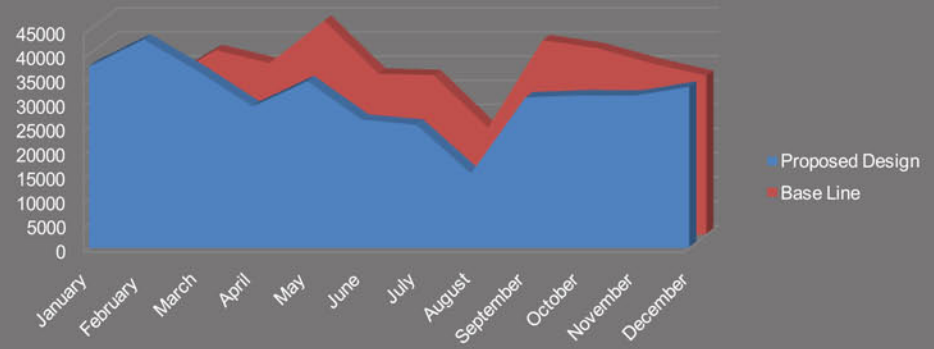



SYMBOL LEGEND

Proposed System Energy Usage as a Percent



Electrical Use Comparison by Month



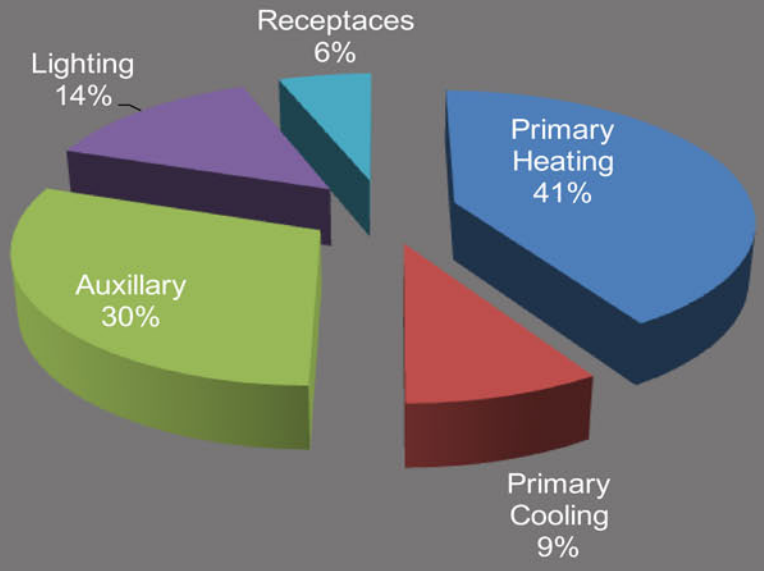
Proposed:

- GSHP
- Back up boiled
- Electric Pre heat

Base line:

- Water cooled Chiller
- Boiler

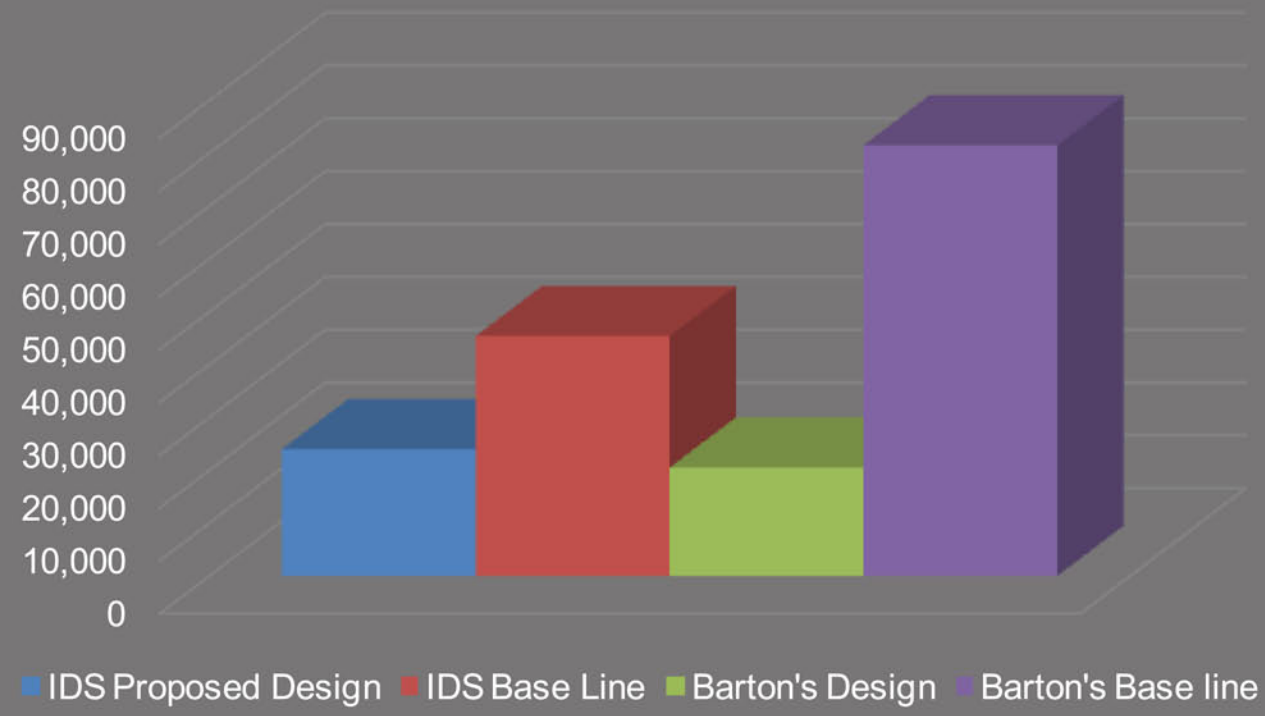
Base Line Energy Usage as a Percent



Energy Efficiency

These diagrams demonstrate our overall improvement from baseline performance in energy efficiency. The total on the right yields us 18 of 19 possible LEED credits for energy efficiency in new building construction. Well done, Jim!

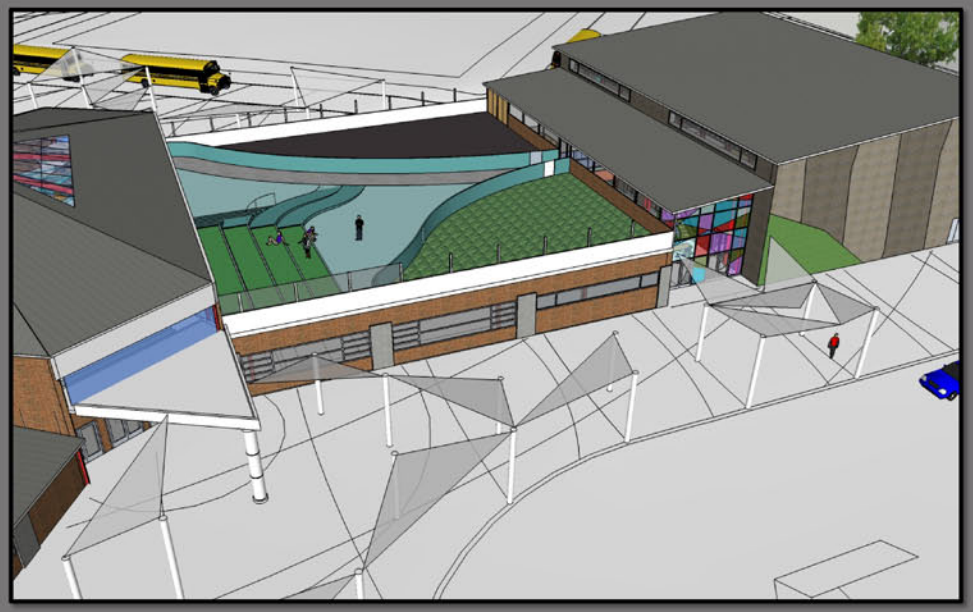
System Energy Consumption in (BTU/sqft)



Percent Improvement = 100(Baseline-Proposed)/Baseline

=100(45,397-23,980)/45,397

46.6%



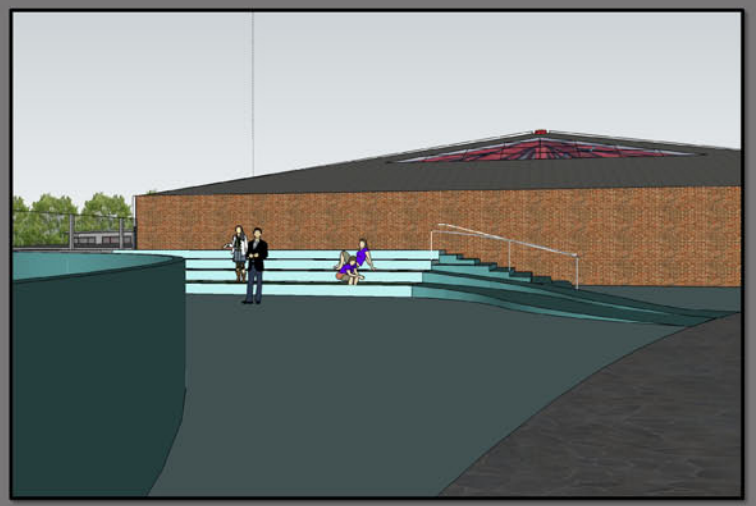
Canopy System

The overhead canopy along the entry plaza help to cover students from the elements as the enter and leave school. This canopy also serves as a visual cue to the primary entrance for evening functions as it's apex sits at the curb in front of the flex space.

The distinct pattern also helps to create a feeling of branching outward from each entrance to the building. This branching pattern pulls the central tree into the outdoor spaces and helps to tie the whole building to the landscape.

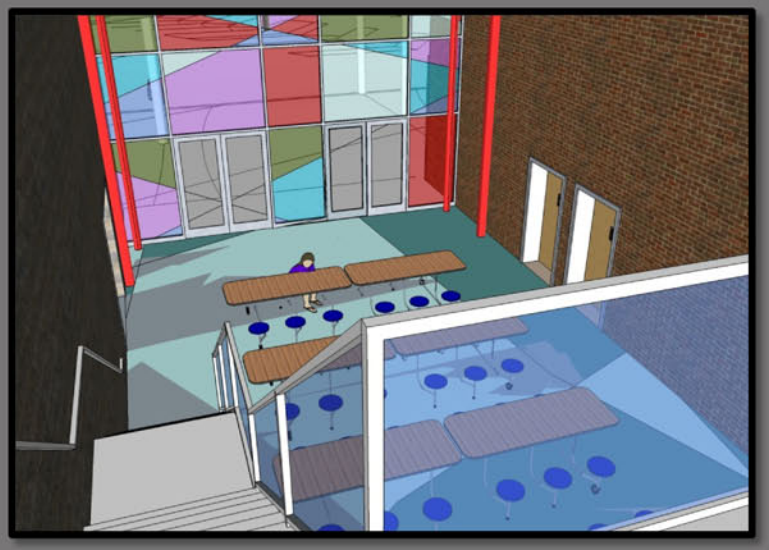
Outdoor Classroom

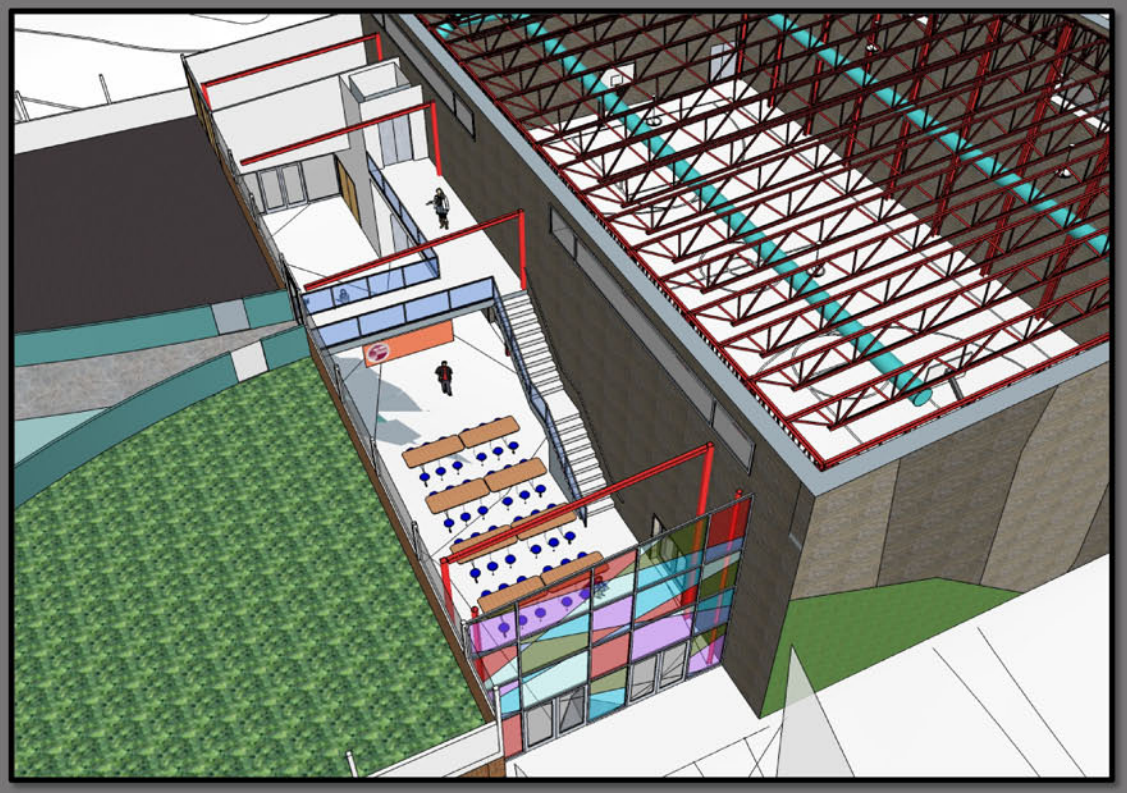
The outdoor classroom provides an interesting outdoor space for learning placed above any commotion on the greenroof. This small terraced classroom provides a view to Mount Nittany through the planted parking lot. To the south is the Tussey Ridgeline which can be viewed rising above the town of Boalsburg.



Flex Space

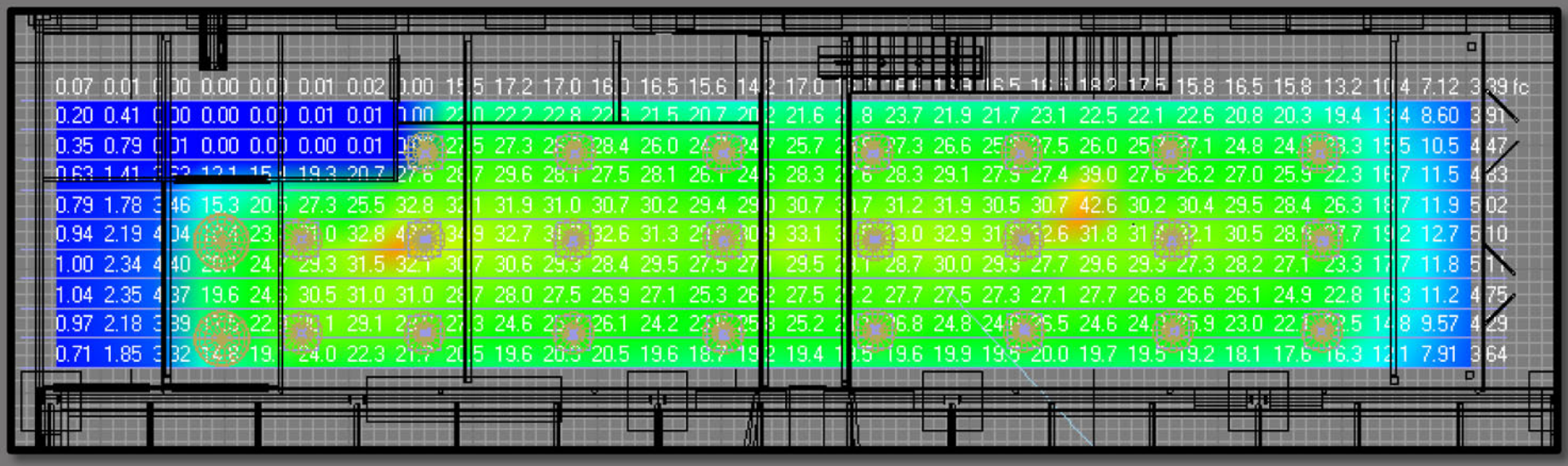
Acting as a cafeteria during school hours, the flex space becomes a lobby for evening events when the tables are stored under the stairs. The amount of glass posed many issues for our Lighting engineer and ultimately it was decided that shades would be used on the upper story to elliminate some direct sunlight.

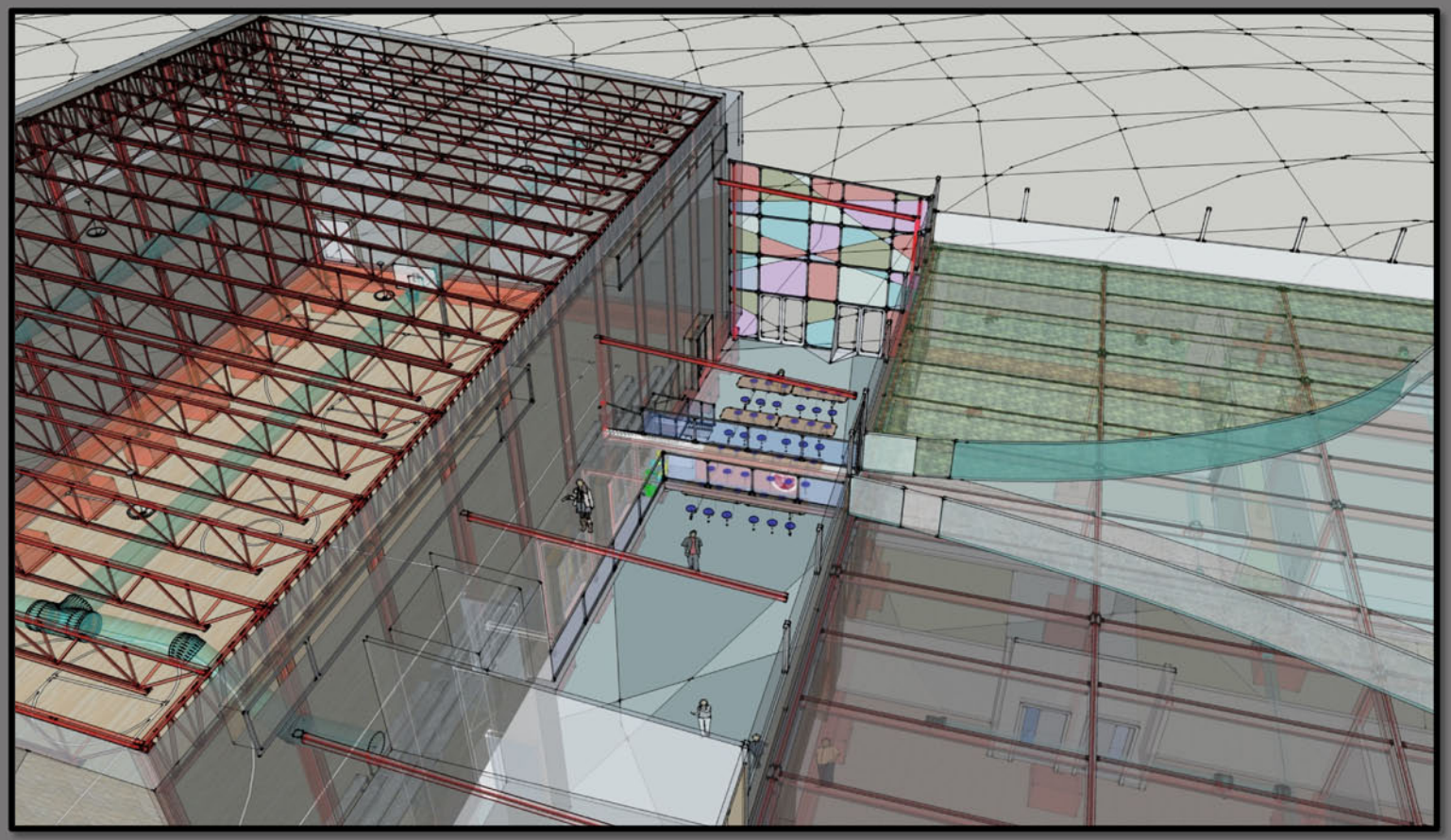


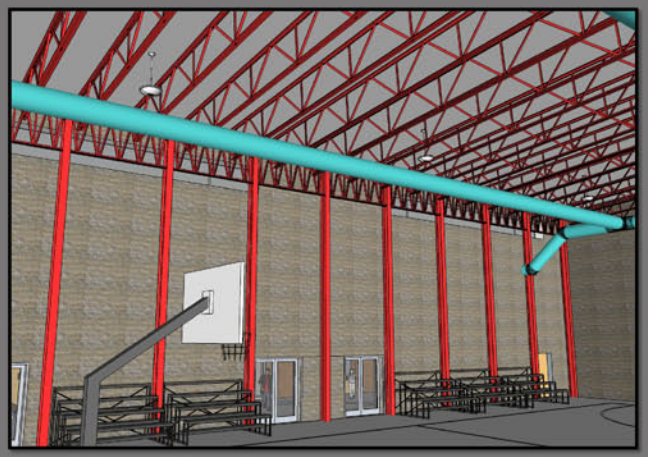


Lighting the Flex

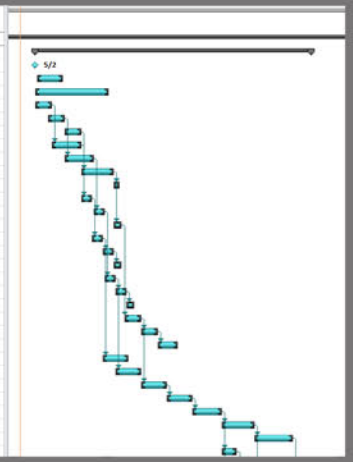
As much sunlight that penetrates the flex space lighting the space for evening events becomes the only electric lights needed for most events held in this space.



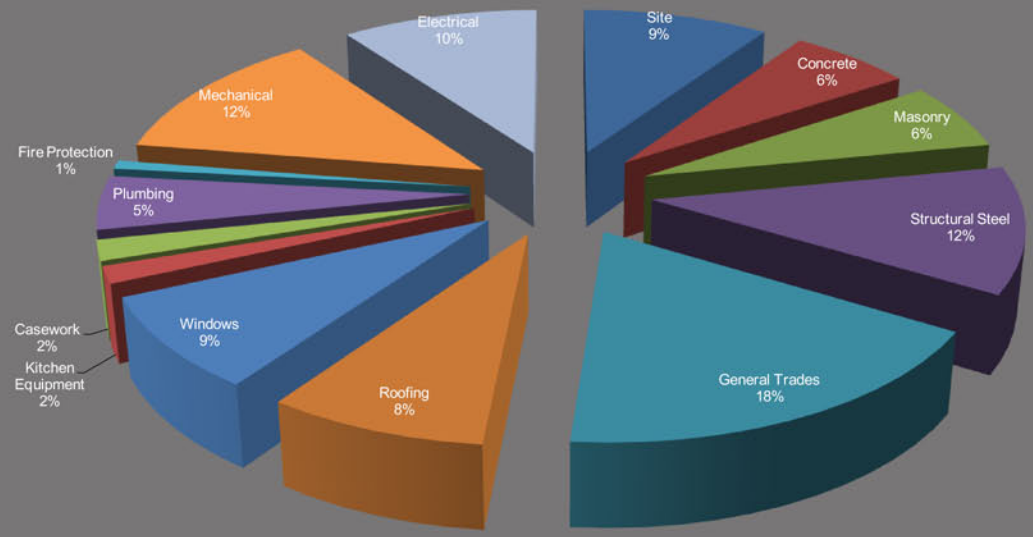




0	Des & Const Schedule Mt Nittant	399 days	Tue 1/11/11	Fri 7/20/12	
1	Design Schedule	134 days	Tue 1/11/11	Fri 4/20/12	
12	Building Enclosure	109 days	Mon 5/2/11	Thu 9/29/11	
13	Construction NTP	0 days	Mon 5/2/11	Mon 5/2/11	
14	Site Mobilization	10 days	Tue 5/3/11	Mon 5/16/11	
15	Site Utilities	30 days	Mon 5/2/11	Fri 6/10/11	
16	Excavate P1	7 days	Mon 5/2/11	Tue 5/10/11	
17	Excavate P2	7 days	Mon 5/9/11	Tue 5/17/11	
18	Excavate P3	7 days	Wed 5/18/11	Thu 5/26/11	
19	Footings P1	12 days	Wed 5/11/11	Thu 5/26/11	16
20	Footings P2	12 days	Wed 5/18/11	Thu 6/2/11	17
21	Footings P3	12 days	Fri 5/27/11	Mon 6/13/11	18
22	Mech Foundation	3 days	Tue 6/14/11	Thu 6/16/11	21
23	Backfill/Waterproofing P1	4 days	Fri 5/27/11	Wed 6/1/11	19
24	Backfill/Waterproofing P2	4 days	Fri 6/3/11	Wed 6/8/11	20
25	Backfill/Waterproofing P3	4 days	Tue 6/14/11	Fri 6/17/11	21
26	Steel Erection P1-Columns	4 days	Thu 6/2/11	Tue 6/7/11	23
27	Steel Erection P1-Girders	4 days	Wed 6/8/11	Mon 6/13/11	26
28	Steel Erection P1-Beams	4 days	Tue 6/14/11	Fri 6/17/11	27
29	Steel Erection P2-Columns	4 days	Thu 6/9/11	Tue 6/14/11	24
30	Steel Erection P2-Girders	4 days	Wed 6/15/11	Mon 6/20/11	29
31	Steel Erection P2-Beams	4 days	Tue 6/21/11	Fri 6/24/11	30
32	Steel Erection P3-Columns	7 days	Mon 6/20/11	Tue 6/28/11	25
33	Steel Erection P3-Girders	7 days	Wed 6/29/11	Thu 7/7/11	32
34	Steel Erection P3-Beams	7 days	Fri 7/8/11	Mon 7/18/11	33
35	SOG P1	10 days	Wed 6/8/11	Tue 6/21/11	26
36	SOG P2	10 days	Wed 6/15/11	Tue 6/28/11	29
37	SOG P3	10 days	Wed 6/29/11	Tue 7/12/11	32
38	Foundation Walls	10 days	Wed 7/13/11	Tue 7/26/11	37
39	Exterior Walls P1	12 days	Wed 7/27/11	Thu 8/11/11	38
40	Exterior Walls P2	12 days	Fri 8/12/11	Mon 8/29/11	39
41	Exterior Walls P3	15 days	Tue 8/30/11	Mon 9/19/11	40
42	Roof P1	6 days	Fri 8/12/11	Fri 8/19/11	39

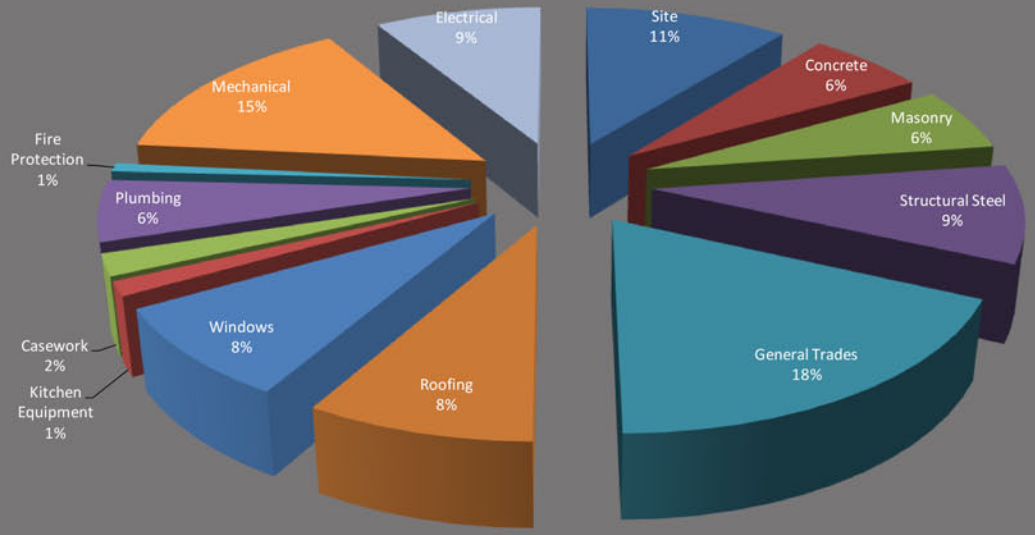


Current School Project Cost Breakdown: $12.8M



Proposed vs Actual Cost Comparison

Proposed School Project Cost Breakdown: $14.3M



Total Project Duration (15 months)

Milestones

- Notice to Proceed
- Structure Complete
- Full Enclosure
- Conditioned Air
- Substantial Completion